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ABSTRACT

Two important elements of a method of designing instructional alternatives (MODIA) are comprehensively discussed in this paper. The "Questionnaire for Stating General Policy" is briefly reviewed to reveal how goals, student population variations, and operations must be accommodated before specifying instructional strategies. The actual strategy specifications are constructed through DISTAF (Determining Instructional Strategies for Training in the Air Force), a computer directed logic tree that assists in planning the instructional methodology. DISTAF has been designed for use with either a simple manual that presents strategies or a complex computer program that enables the planner to use up to 57 different teaching strategies. The computerized tree allows the planner to take account of many different levels of subject matter difficulty and student abilities. DISTAF presents the planner with a variety of choices during the development of a workable strategy. It can categorize students into tracks, choose types of examinations and learning experiences, and enable the planner to construct detailed strategies in 10 to 30 minutes. (MC)

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The MODIA Decision Process for Developing Strategies of Air Force Instruction

Polly Carpenter and Barbara Horner

A Report prepared for

UNITED STATES AIR FORCE PROJECT RAND

EM 010 469

Rand
SANTA MONICA, CA. 90406

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PREFACE

This is one of four interrelated reports describing Rand work for the Air Force to date on the development of methodologies for designing programs of instruction. The reports in the series are:

R-1018-PR, *An Overview of MODIA: A Method of Designing Instructional Alternatives for Air Force Training,* Polly Carpenter.
R-1019-PR, *The MODIA Decision Process for Developing Strategies of Air Force Instruction,* Polly Carpenter and Barbara Horner.
R-1020-PR, *The MODIA Questionnaire for Curriculum Analysis,* Rudy Bretz.
R-1021-PR, *MODIA Applied in the Design and Cost Analysis of an Innovative Air Force Course,* Robert L. Petruschell and Polly Carpenter.

The first of these provides an overview of the methodologies being developed; the second and third describe some of the major analytical tools used to provide inputs to the design process; and the last sets forth the results of a completed design cycle, parts of which were carried out manually, applied to a specific course in Air Force technical training.

This work has been conducted under a Rand project entitled *Analysis of Systems for Air Force Education and Training.* Emphasis has been on the use of technology in designing instruction for formal technical training or for higher education, as at the Air Force Academy. The results will support the activities of the Director of Personnel Plans, Headquarters USAF; DCS/Technical Training and the Training Development Directorate, headquarters Air Training Command; and the Air Force Human Resources Laboratory, especially the Technical Training and Professional Education divisions. It will be of particular interest to those working on the Advanced Instructional System.

This report is part of a continuing Rand effort to apply systematic methods of analysis and synthesis to issues and problems in education and training. Related studies have concerned Air Force pilot training and management of the pilot force, evaluation of programs of compensatory education, design of information systems for local school districts, and other diverse concerns. A special bibliography of Rand work in education is available on request.

3-2-73

ERRATUM

R-1019-PR THE MODIA DECISION PROCESS FOR DEVELOPING STRATEGIES OF AIR FORCE INSTRUCTION, Polly Carpenter and Barbara Horner, November 1972, Unclassified

The Professional Education Division of the Air Force Human Resources Laboratory, mentioned in the Preface, was disbanded in July 1972 and no longer exists as an organizational unit.

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SUMMARY

The Air Force expends several billion dollars annually on education and training; in technical training alone, it spends over half a billion dollars and graduates more than 150,000 men a year from five technical schools and numerous courses of on-the-job training. The high cost of traditional methods of technical training has stimulated Air Force research on new educational methods. Since 1968, Rand has been working on the design of instructional programs to help the Air Force, especially the Air Training Command, to determine systematically the mix of instructors, facilities, materials, and students that should go into its training and other instructional programs.

RESULTS

As a result of this work, Rand has developed MODIA (A Method of Designing Instructional Alternatives), a comprehensive methodology for designing an instructional system. MODIA consists of a sequence of procedures and semiautomated "tools," that allow a planner to examine many alternative instructional approaches *before* he puts an actual system into use. He can rapidly plan a program for a particular approach and—still at the planning stage—assess its utility in terms of production of graduates or consumption of human and material resources. If the program is unacceptable on one of these counts, the planner may quickly construct and assess an alternative approach.

This report, one of a series of four, describes a unique and practical tool for instructional design—a decision process for developing teaching strategies. It includes two important elements: a Questionnaire for Stating General Policy, and a computer-directed logic tree called DISTAF (Determining Instructional Strategies for Training in the Air Force) that helps the user plan in detail his teaching methodology for a given class.

These elements and other tools are used in the MODIA process, which consists of eight steps:

1. Analyze characteristics of the learner population that will affect the way the course will be taught.
2. Use the Questionnaire for Stating General Policy to specify the broad goals underlying the teaching institution's operation.

3a. Use the Curriculum Analysis Questionnaire to typify each lesson in system-oriented terms and to characterize each lesson's requirements for communication media.

3b. Specify instructional strategies with the help of DISTAF. Each strategy identifies the teaching agent and the way students will interact with this teaching.

4. Specify design criteria input from the teaching institution, such as least course cost, shortest course length, or maximum student graduation rate.
5. Describe local resources such as the number of students entering the school and the school's resources and constraints.
6. Design the instruction using as direct inputs information from the Curriculum Analysis Questionnaire, DISTAF, the design criteria, and the local resource description.
7. Analyze the costs to determine the system's time-dependent dollar requirements.
8. As necessary, depending on the acceptability of the outputs, repeat steps 1-7 (with different inputs) until the most desirable system emerges.

Some major tools must be developed before MODIA is complete, namely, a generalized computer model of student flow; a computer model for estimating resource requirements; and a questionnaire for detailing local resources. Although work remains, MODIA was tested manually on part of a basic still photography course at Lowry Air Force Base (described in R-1021-PR, cited in the Preface), allowing us to make three broad and important conclusions with confidence:

- Systematic, generalized methods can be developed for designing programs of instruction;
- These techniques encourage the examination of alternative approaches to instruction;
- A comprehensive, systematic approach stimulates the development of insights into the design of instruction that would otherwise not occur.

The work has been directed toward very general applications so that it will be useful not only to Air Force organizations such as the Air Training Command and the Air Force Academy, but also to training and educational institutions in the public sector.

SPECIFICS OF THIS REPORT

The Questionnaire for Stating General Policy considers policies in three general areas: the broad characterization of the teaching institution's goals, the extent to

which the schools will adjust to variations in the student population, and the way in which the schools must accommodate their operations to organizations that supply their students or accept their graduates.

Once the planner completes the Questionnaire, he is ready to specify his instructional strategies in detail using DISTAF. For its use, we constructed two aids: one is a manual presenting the strategy decisions the planner will have to make; the other is a time-shared computer program written in JOSS (Rand's on-line interactive computer system).

The manual discusses the pros and cons applicable to each decision along with some of the logical consequences that will result from various choices. In itself, the manual gives the planner a comprehensive checklist. If he decides to use a very simple instructional strategy, he can proceed through the decisionmaking process at his own direction. If he wishes to specify a highly varied strategy, he uses the computer program.

The program *computes* nothing. Rather, it keeps track of the planner's decisions and performs all the logical bookkeeping, which can be quite complex. Whereas most instructors use only a few approaches to instruction, DISTAF permits specification for a single course of up to 57 different teaching strategies. This provides the planner with opportunities to take account of many different levels of subject matter difficulty, different student abilities, and requirements for different types of student performance. To use the program, the planner sits at the computer console and answers questions of strategy as the computer directs him to do. At each point the computer refers him to the appropriate question in the manual to remind him of the arguments for and against each choice.

While working through the decision process, the designer makes the following kinds of choices: whether and to what extent to adapt course content to the students and on what basis to make the adaptation; whether and to what extent to adapt the teaching method to student capabilities to learn the subject; if he uses either kind of adaptivity, whether to categorize students into tracks or within-class groups and, if so, how many. He also chooses how to schedule formal examinations, whether to make them objective or essay, and how comprehensive to make them; whether or not to schedule formal reviews and homework; what kind of learning experience categories to use, such as classroom drill, laboratory practice, or demonstration; who controls the learning experience—students, instructors, or media; whether or not students must respond overtly in some way—answering multiple-choice questions, writing answers in essay form, or perhaps performing some skill; and whether or not to give the students immediate knowledge of the correct response.

The computer speed and program organization make it possible for the designer to construct many strategies in a relatively short period. Although he may take several hours for his first run, as he becomes more familiar with the decision points the time for a run will be reduced to from 10 to 30 minutes, depending on the complexity of the strategy chosen.

Although the decision process is intended to provide input for a semiautomated methodology for designing instructional programs, it has several values in its own right:

- It assists the planner in making explicit his judgments about what constitutes effective instruction.
- It assists the planner in stating policies that guide school and classroom operations.
- It provides a comprehensive, logically consistent set of decisions that should be considered in planning instruction.
- For the first time, it describes teaching methods in terms that will guide the instructional program design.

ACKNOWLEDGMENTS

We wish to thank our Rand colleagues, Rudy Bretz and Robert Petruschell, for major assistance in developing the concepts and format of the DISTAF program. Their insight and patient support were essential to the work reported here. Our thanks also go to Erwin Gordon for helping us make the work comprehensible to others. Marjorie Rapp and Duncan Hansen reviewed the manuscript, which is much better for their careful reading and helpful suggestions. Thanks are also due to Bernice Jacobs, Mary Jo Parise, and Roberta Schneider for their patience and expert assistance in preparation of the manuscript.

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I. INTRODUCTION

Since 1968, Rand has been working on the design of instructional programs to help the Air Force, especially the Air Training Command, to determine systematically the mix of instructors, facilities, materials, and students that should go into its training and other instructional programs. As a result of that work, Rand has developed MODIA, a comprehensive methodology for designing an instructional system. MODIA (A Method of Designing Instructional Alternatives) consists of a sequence of procedures and semiautomated "tools," some of which have already been designed and are described in this series of reports. This report describes a decision process for developing teaching strategies. It includes two elements: a Questionnaire for Stating General Policy and a computer-directed logic tree called DISTAF (Determining Instructional Strategies for Training in the Air Force) that helps the planner extract the detailed implementation of his teaching methodology for a given class.

GENERAL APPROACH

To provide a context for the Questionaire and DISTAF, we briefly discuss our overall MODIA process step by step, as shown in Fig. 1. The process is intended to provide such characteristics of the instructional system as course length; student flow; and what facilities, equipment, personnel, and dollars are needed, and when. By means of MODIA, planners should be able to design an instructional program efficiently and with confidence both that the outputs are acceptable to the teaching institution and that the methods of teaching the course are appropriate to the learners. The steps are described below.

- *Step 1—Analyze the learner population* in terms that will affect the way the course is taught.

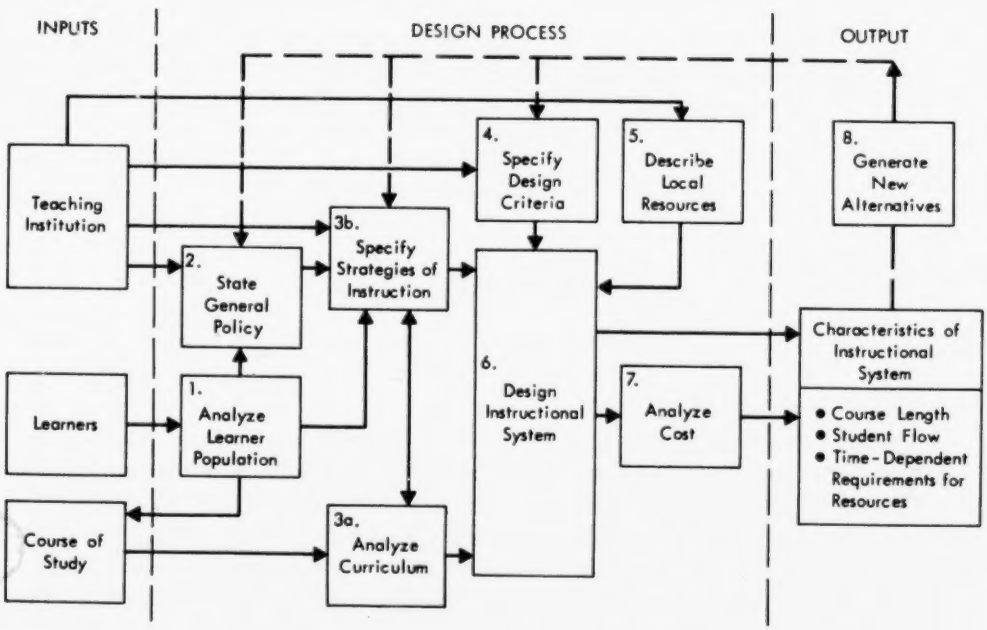


Fig. 1—The design process

- *Step 2—State general policy* using the Questionnaire described in Sec. II and Appendix A of this report.[1]
- *Step 3a—Analyze the curriculum* using a branching questionaire that helps the user describe his course in detail.[2] The Curriculum Analysis Questionnaire typifies each lesson (1) in system-oriented terms and (2) its requirements for communication media.[3]
- *Step 3b—Specify strategies of instruction* as described in this report by means of DISTAF, a logic tree, with each decision point a logical consequence of the preceding decisions. To exercise it, the designer has two aids: an interactive computer program written in JOSS,[4] and a User's Manual that presents the pros and cons of decisions to be made at each point, along with some of the logical consequences of each choice. For each type of

[1] Policy, as used here, concerns the nature of the school's objectives—whether it wants a standard or a diverse output, and how it relates to institutions that use its graduates and those that supply its students.

[2] Rudy Bretz, *The MODIA Questionnaire for Curriculum Analysis*, The Rand Corporation, R-1020-PR, November 1972.

[3] Rudy Bretz, *The Selection of Appropriate Communication Media for Instruction: A Guide for Designers of Air Force Technical Training Programs*, The Rand Corporation, R-601-PR, February 1971.

[4] The JOSS computer program will be published as a Supplement to this report, and eventually will be translated into Interactive FORTRAN.

instruction identified in the Curriculum Analysis Questionnaire, an instructional strategy specifies the teaching agent and the way students will interact with this teaching.

DISTAF encourages the planner to consider alternative methods of instruction (up to 57 different teaching strategies for a single course) and to translate his decisions into guidelines for program design. This allows him to take account of different levels of subject matter difficulty, different student abilities, and requirements for different types of student performance.

- *Step 4—Specify design criteria* input from the teaching institution, such as least cost, shortest course length, graduation of the most students per unit time, or maximum use of communication media.
- *Step 5—Describe local resources,* presents data describing the rate of student entry and the school's resources and constraints, which will be gathered by means of a logically structured set of questions.
- *Step 6—Design the instructional program* using as direct inputs information from the Curriculum Analysis Questionnaire, DISTAF, the design criteria, and the local resource description. Indirect inputs are characteristics of the learner population, the stated general policy, and the general course features.

  At present, we see four main components of this step. First, each lesson is linked to the instructional strategy chosen for that particular category of instruction. Second, a set of criteria is used to select specific media and facilities. Third, a set of criteria is used to assign personnel. Fourth, student flow through the course is simulated by a flow and scheduling model to generate graduation rates and resource requirements.

- *Step 7—Analyze the costs* to determine the system's time-dependent dollar requirements. This will eventually be accomplished by a computer program.
- *Step 8*— As necessary, depending on the acceptability of the outputs, repeat steps 1-7 (with different inputs) until the most desirable system emerges.

Probably the most important single contribution of MODIA is that it encourages the examination of alternative instructional approaches. It helps the designer plan a program for a particular approach rapidly, and—still at the planning stage—assess its utility in terms of production of graduates or consumption of human and material resources. If the resulting instructional program is unacceptable on one of these counts, the designer may quickly construct and assess an alternative approach. Providing this kind of feedback will help assure that many promising approaches are explored *before* one is chosen for actual implementation.

Some major tools must be developed before MODIA is complete, namely, a generalized computer model of student flow; a computer model for estimating re-

source requirements; and a questionnaire for detailing local resources. Although work remains, we manually tested MODIA to demonstrate the feasibility and utility of the design process; our example for the test is based on an actual course in still photography taught to enlisted airmen in the Technical School at Lowry Air Force Base.[5]

ORGANIZATION OF THE REPORT

Section II describes the Questionnaire for Stating Gereral Policy, presented in Appendix A. The remainder of the report deals with several aspects of specifying instructional strategies in detail. First, Sec. III describes the strategies available to the planner. It also shows how these are related to the teaching methods of everyday educational parlance. Next, the effects of the various instructional strategies on system design are discussed in Sec. IV. Section V then describes the logical structure of DISTAF, the interactive logic tree, and will be of particular interest to anyone concerned with the details of the DISTAF program. Concluding remarks are given in Sec. VI. In addition to Appendix A, mentioned above, Appendix B contains the User's Manual for Specifying Instructional Strategies, which is used in conjunction with the DISTAF program. Appendix C displays and discusses the instructional strategy as output by the DISTAF program for the basic photography course mentioned above. And Appendix D contains a list of variables.

[5] R. L. Petruschell and Polly Carpenter, *MODIA Applied in the Design and Cost Analysis of an Innovative Air Force Instructional Course*, The Rand Corporation, R-1021-PR, November 1972.

II. STATING GENERAL POLICY

Ground rules for designing an instructional program fall into two general categories—policy and strategy. Policies concern mainly the very broad goals underlying school operation, strategies concern how to carry out these policies. As indicated in Sec. I, the explicit statement of policies guides the specification of instructional strategies.

In the Rand work, we consider policies in three general areas: the broad characterization of the teaching institution's goals, the extent to which the schools will adjust to variations in the student population, and the way in which the schools must accommodate their operations to the needs of organizations that supply their students or accept their graduates (scheduling). To assist the planner in stating these policies, the Questionnaire for Stating General Policy (Appendix A) was constructed. It is tied to the analysis of student population and provides input variables for DISTAF.

GOALS OF THE TRAINING INSTITUTION

We discuss the Questionnaire as it relates to the three areas mentioned above. Answers to the first two questions provide a very general characterization of the institution's goals.

1. Will a standard number of instructional hours be required as input, regardless of course content or **student capability**?*
2. Are standardized graduates desired?

First, the planner indicates whether the teaching institution must provide a "standard number of instructional hours" for every student. This type of requirement is legally mandated for public schools in many states, is required in most institutions of higher education, and is also prescribed in many training programs for labor

* Items defined in the Glossary appear in boldface type the first time they are mentioned in the text.

union membership. Because our concern has not been primarily with such institutions, at this point a "yes" answer to question 1 would halt the design process (although relatively few modifications will be needed for the process to reflect this general policy). A "no" answer sends the designer to question 2.

Question 2 deals with whether the planner wants the graduates to be as similar as possible (standardized) with respect to their mastery of the course. No one believes, of course, that it is possible or even desirable to produce graduates who all have exactly the same level of mastery of the same set of skills. Air Training Command policy at present, however, devotes no additional resources to helping more capable students attain higher levels of mastery; rather *all* students are expected to master a given minimum set of objectives. Such a policy certainly alleviates problems of personnel assignment, but may stifle the curiosity, initiative, and creativity of the better student. Professors in the Air Force Academy who would wish to develop the potential of each commissioned officer to the fullest would probably reply positively to this question.

ADJUSTING TO DIFFERENCES IN STUDENTS

Content Variations

Question 2 also relates to variations in the student population. If students are relatively homogeneous, it makes little difference whether a standardized graduate is desired. If they vary widely in their capabilities to master the subject matter, however, those with better capabilities may be expected to master a larger set of objectives than the average student in order to develop their potential more fully. Therefore, the designer is asked:

3. Will better students be encouraged to go beyond average achievement?

Additional objectives can also help keep the bright student from becoming bored. Similarly, students with lower capabilities may be expected to attain a smaller set of objectives, a set from which work that is not essential or too challenging has been deleted.

4. Will requirements be relaxed for poorer students?

Students who have difficulty in learning the subject will work as hard to attain a limited set of objectives as will the average students to master the standard course materials. Similarly, bright students may quickly master and become bored with the standard course and may need the challenge of additional objectives. Although this tactic equalizes, to some extent, the demands placed on the students, it may result in inequalities in student learning that compound over time.

The replies made to questions 3 and 4 will affect both student flow and the

Curriculum Analysis, in which **learning events** required for enrichment or those that can be deleted must be identified and described.

5. Will exposure to course content be matched to prior student achievement?
6. Will additional instruction be given to students who are deficient in course prerequisites?
7. Will students with superior preparation be allowed to skip topics they already know?

"Yes" answers to questions 5 and either 6 or 7 will have similar effects on student flow and the Curriculum Analysis. If question 5 is answered "yes," however, course content is to be adapted (**adaptivity**) to the student's prior preparation for the course. Those who are deficient in course prerequisties may be given remedial instruction (question 6) or those with superior preparation may be allowed to skip topics they already know (question 7). DISTAF later provides the designer with an opportunity to specify at what point and how to identify such students.

Adapting course content to prior student learning primarily affects the efficiency of instruction, as it is directed toward teaching students only what they need to learn to master the course objectives. It may be adopted whether or not standardized graduates are desired and will be most useful in situations in which the student population has highly diverse backgrounds.

Method Variations

8. Will different instructional strategies be designed to match different student capabilities?
9. Will special strategies be used for better students?
10. Will special strategies be used for poorer students?

Questions 8 to 10 determine whether the designer wants to take student capability into account in choosing instructional methods. (Student capability is a mixture of motivation, innate ability, and prior achievement.) This is a crucial step, particularly for a highly heterogeneous student population. "Yes" answers here determine how much variety in method and **materials** will be supplied. In the usual classroom, such decisions are left to the instructor who must assess the heterogeneity of his students and, usually through trial and error, reach them as best he can. Even the most competent instructors can be stymied by a highly heterogeneous class and a limited set of materials.

Variations in method may consist of breaking subject matter into small steps for the slow learner, challenging fast learners to discover principles for themselves, allowing slow learners more time on a particular topic, or letting fast learners direct their own study independent of an instructor. DISTAF permits a wide range of variations by taking the planner through the process of setting strategy for each ability grouping he wishes to consider for various levels of subject matter difficulty.

The planner's decisions about which levels of student capabilities he wishes to

consider separately are clearly influenced by the distribution of capabilities he expects in the student population. Policy considerations also influence his decisions, for example, whether the community will be friendly or hostile to special treatment for the fast learner.

Tracking and Grouping

To make it easier to adapt either method or content to various characteristics of the student population, frequently students are put into **groups** that are relatively homogeneous with regard to the characteristics of interest. Each group may then be taught differently either by using different methods or by spending differing amounts of time in teaching them, or by combinations of both techniques. Students may be put into groups whose members may change from time to time, depending on the instruction.

Alternatively, tracking (**tracks**) puts students into classes whose members remain essentially the same throughout the course; in effect, separate but parallel courses are taught. Tracking may have undesirable psychological effects on both instructors and students, but it permits a greater concentration of resources on the learner and may result in a higher overall level of learning. Within-class grouping makes greater demands on the instructor's ingenuity.

11. Will students be put into tracks?
12. Will students be put into tracks on the basis of their learning capability?
13. Will students be put into tracks on the basis of their preparation for the course?

Since tracking affects the entire course and may be a matter of policy, the designer is asked in question 11 whether he will use it. If so, he then establishes in questions 12 or 13 the basis for track formation, depending on the types of adaptivity he has previously chosen. If he chooses only one basis, say student learning capability, his prior answers to questions 3 and 4, for example, will be sufficient to direct the formation of tracks. If he chooses two bases, he will use his analysis of student population and the types of adaptivity he has selected to guide him in forming the tracks. The number and type of tracks formed will then be input to DISTAF so that instructional strategy may be specified for each track.

SCHEDULING

When a standard number of instructional hours is not required as input, it is possible to save time and other resources by encouraging average and fast learners to graduate more quickly than slow learners. In addition to being more efficient, this tactic may give the student a greater sense of control over his own learning and, hopefully, encourage the development of responsible attitudes. These advantages

may outweigh the disadvantages of greater administrative burdens and greater demands on teacher inventiveness.

Most instruction, however, is designed so that all students will learn certain basic sections of course content on a fixed schedule. This simplifies such tasks as scheduling tests, assigning teachers and classrooms, predicting the availability of graduates, and ordering supplies. And, if wisely managed, there can be a fair amount of adaptivity within what is sometimes called **lock-step instruction**. Moreover, the user of the graduates may want them supplied in predictable numbers at regular intervals, as is the case in the Air Force personnel system. Thus, it is important to consider whether students must master course content on a fixed schedule so that the user will be predictably supplied.

14. Will basic course content be presented on a fixed schedule?
15. Will additional resources in the form of remedial instruction or washback be used for slow students or students who have been absent?
16. Will failing students be dropped from the course before its conclusion?
17. Will basic course content be presented on a fixed schedule within tracks?

Question 14 applies if no tracking is being used; question 17 applies to tracking. It may be considerably easier to meet the user's requirements and still accommodate student differences if tracks are used with a fixed schedule for each track.

If fixed scheduling is used, examinations are given on a fixed schedule, and students who do poorly on the test must either take remedial instruction to make it up, repeat the material covered, or be eliminated from the course. Additional resources are also needed to catch up students who have had excessive absences. Therefore, question 15 allows the planner to specify whether he wishes to provide additional resources for these purposes. Additionally, students who are failing may be dropped from the course before its conclusion (question 16). This saves both instructional resources and student time.

III. INSTRUCTIONAL STRATEGIES

This section provides the reader with a general understanding of the process for specifying instructional strategies. It begins by describing the planner's role. The process is structured around a framework of categories of instructional activities classified according to the teaching resources inherent in the subject matter. The categories are described and then compared with other, current systems for classifying instruction. Within each category, questions are asked whose answers establish the detailed features of the teaching strategy to be used. Some strategy questions and answers are then described. The section ends by showing how some sets of answers to the strategy questions relate to current teaching methods.

HOW THE PLANNER SETS STRATEGY

Once the planner completes the Questionnaire for Stating General Policy, he is ready to specify his instructional strategies in detail using DISTAF. For its use, we constructed two aids: one is a manual presenting the strategy decisions the planner will have to make; the other is an interactive computer program written in JOSS that guides him through a logic tree.

The manual discusses the pros and cons applicable to each decision along with some of the logical consequences that will result from various choices. In itself, the manual gives the planner a comprehensive checklist. If he decides to use a very simple instructional strategy, he can proceed through the decisionmaking process by himself. If he wishes to specify a highly varied strategy, he uses the computer program. The program *computes* nothing. Rather, it keeps track of the planner's decisions and performs all the logical bookkeeping, which can be quite complex. To use the program, the planner sits at the computer console and answers questions of strategy as the computer directs him to do. At each point the computer refers him to numbered questions in the manual to remind him of the arguments for and against each choice.

The logic tree is based on three types of instruction that provide a framework for the DISTAF process. At branch points, each category of instruction may be

divided into several subcategories, some of which are shown in Fig. 2. For each subcategory of instruction included in his course, the planner specifies a strategy by answering a set of questions. Thus, whereas most instructors use only a few approaches to instruction, DISTAF permits specification for a single course of up to 57 different teaching strategies, one for each subcategory of instruction. This provides the planner with opportunities to take account of many different levels of subject matter difficulty, different student abilities, and requirements for different types of student performance.

It will probably take a user several hours to make his first run through the DISTAF program. As he becomes familiar with the decision points, however, this time will diminish to from 10 to 30 minutes, depending on the complexity of the strategy chosen.

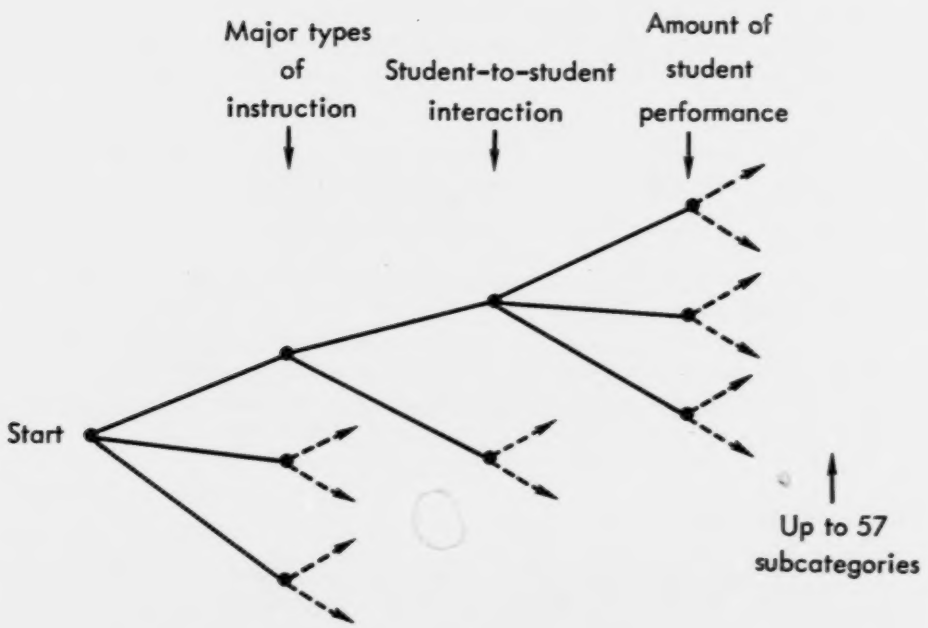


Fig. 2—Logic tree

CATEGORIES OF INSTRUCTION

Let us now examine the three major categories of instruction.[7] **Type I instruction** does not require students to develop skills through drill or practice. Much **conventional** classroom **instruction** is of Type I. **Type II instruction** requires students to develop skills through drill or practice but does not require them to work with **special equipment** or in **special facilities**. Thus, Type II is also classroom instruction. **Type III instruction** requires the students to work with special equipment or in a special facility, which means elsewhere than in a classroom or **carrel**.

As shown partially in Fig. 2, each type of instruction is divided into the subcategories shown fully in Table 1A. Each column (1 to 7) indicates a basis on which subcategories are formed; each also may influence the way in which subcategories to its right on the table are chosen. Shaded boxes indicate some subcategories whose formation is not subject-matter dependent, such as **unscheduled instruction** (homework). The shaded boxes are included because the available choices of answers for the strategy questions at the finest level of detail depend on these categorizations.

The number and type of categorizations that the user chooses to call out on the basis of student learning capability (column 6) are related to the type of instruction and its level of difficulty. Generally accepted learning-capability categorizations are as follows:

1 group	no categorization
2 groups	slow and average-to-bright or slow-to-average and bright
3 groups	slow, average, bright

The user may choose different categorizations at different levels of difficulty, as suggested by the example in Table 1B.

The requirement of the subject matter for **constructed response** (a response the student devises himself—column 7) would seem to have a small role or no role to play in the judgment about the number of categories of student learning capability chosen; hence, column 7 is to the right of column 6.

Type I Instruction

For convenience, each subcategory in Table 1A is assigned a line number (last column), to which the following discussion refers. Type I instruction (lines 1 to 3) is not subcategorized on the basis of requirements for student-to-student interaction or student **performance** because, by definition, Type I instruction is not intended to teach skills.

Unscheduled Type I instruction (answered "no," line 1) is traditional homework and has been treated very simply. We have not asked the designer to assign a level of difficulty to tailor this instruction to student learning capabilities (to some extent, the student does this anyway), or to consider requirements for special presentations

[7] The Glossary contains fuller descriptions of the three types of instruction.

Table 1A

DISTAF CATEGORIES OF INSTRUCTION

Column Number							
1	2	3	4	5	6	7	
Type of Instruction	Student-to-Student Interaction Required?[a]	Student Performance Required?[b]	Scheduled Instruction?[c]	Level of Difficulty	Categories of Student Learning Capability[d]	Constructed Response Required?	Line Number
Type I	N.C.[e]	N.C.	No	N.C.	N.C.	N.C.	1
			Yes	Easy	Up to 3	N.C.	2
				Difficult	Up to 3	N.C.	3
Type II	No (individual skills)	No (model of student performance)	No	Simple	N.C.	N.C.	4
				Complex	N.C.	N.C.	5
			Yes	Simple	N.C.	N.C.	6
				Complex	N.C.	N.C.	7
		Yes (student performance)	No	Simple	N.C.	Yes	8
						No	9
				Complex	N.C.	Yes	10
						No	11
			Yes	Simple	Up to 3	Yes	12
						No	13
				Complex	Up to 3	Yes	14
						No	15
		Mixed (follow-me instruction)	No	N.C.	N.C.	N.C.	16
			Yes	N.C.	Up to 3	N.C.	17
	Yes (interactive skills)	No (model of interactive performance)	N.C.	N.C.	N.C.	N.C.	18
		Yes (interactive performance)	N.C.	N.C.	N.C.	N.C.	19
Type III	See Type II instruction and text description of Type III instruction.						20-35

[a] If the subject matter requires students to interact with each other because they are learning interactive skills (as in close-order drill or crewing an aircraft), this column is answered "yes." Otherwise, it is answered "no," even if students interact with each other during the instruction, as in small group discussions or directed classroom drill.

[b] If the subject matter requires students to perform in order to learn a skill, this column is answered "yes," unless the instruction comprises the presentation of a model of the skill to be learned. In that case, the answer is either "no" or "mixed," depending on whether the student observes the presentation without performing or follows the demonstration step-by-step.

[c] Columns headed by shaded boxes indicate policy-dependent subcategorizations, as opposed to those that are subject-matter dependent.

[d] If the method of instruction is to be adapted to student learning capability, DISTAF allows the planner to specify different strategies for up to three categories of students. If, for example, three categories are used, a subcategory to the right is tripled. An example is shown in Table 1B.

[e] N.C. means that the instruction is not subcategorized on this basis. In some instances, the planner must assign a single value to this variable; in others, the variable is assumed irrelevant.

Table 1B

EXAMPLE OF CATEGORIZATION BASED ON STUDENT LEARNING CAPABILITY[a]

Column Number from Table 1A				
1	4	5	6	
Type of Instruction	Scheduled Instruction	Level of Difficulty	Categories of Student Learning Capability	Line Number from Table 1A
Type I	No	N.C.	N.C.	1
	Yes	Easy	Slow	2
			Average-to-bright	2
		Difficult	Slow	3
			Average	3
			Bright	3

[a]Only Type I considered; columns N.C. for all Type I deleted. Had the user wished, he could have chosen 3 categories of student learning capability for line 2.

because all presentations must be recorded for student use. We do ask, however, that he designate the type of response (if any) to be elicited for all instruction in this category.

Scheduled Type I instruction (lines 2 and 3) is traditional classroom instruction (although the planner's choices may make it necessary for the students to work in study carrels at a learning center). If the planner wishes to elicit **overt responses** from the students during this instruction, he chooses the type of response (column 7) for all instruction in each of up to the six categories that may be formed on the basis of student learning capability.

Type II Instruction

Because unscheduled Type II instruction (also traditional homework) can apply to such diverse activities as practicing addition or writing a term paper, it is broken into seven subcategories, as shown in lines 4, 5, 8 to 11, and 16. It is not, however, categorized on the basis of student learning capability or special presentation requirements. Whatever presentations must be made would consist of stimuli for drill, problems for solution, or directions, all of which would direct student performance (lines 8 to 15); or of showing a model of the skill to be learned (lines 4 to 7 and 16 and 17).

If students do not perform the skill during the showing of the model (lines 4 to 7), the instruction is not subcategorized on the basis of student learning capability and no decision must be made concerning the type of response. If students do perform the skill during the showing of the model (lines 16 and 17), constructed response is assumed to be required. **Follow-me instruction** is assumed useful only with complex skills, so it is not subcategorized by level of difficulty, but may be subcategorized by student learning capability.

Type II instruction may teach interactive skills such as dramatic production or debating (lines 18 and 19). The Curriculum Analysis provides most of the data for determining what configuration of facilities and personnel is needed for these categories. No unscheduled instruction is included on the assumption that the requirements for assembling a team or group will force the instruction to be scheduled.

Type III Instruction

The subcategorizations of Type III instruction (not shown explicity in the table) follow those of Type II very closely, although the reasoning behind them is somewhat different. Because Type III instruction concerns the development of student skills in working with special equipment or in special facilities, *all* presentations (except brief directions) require special facilities or equipment. This breaks the "mixed" category of Type II instruction (lines 16 and 17) into two subcategories depending on intent: (1) it is true follow-me performance with each student copying a demonstration as it is presented, or (2) the students are only following step-by-step directions. In the first case, a **model of performance** must be prepared and carried out; in the second, such a model is not used. In either event, each student must have access to the required facilities or equipment during the presentation.

Discussion, Review, Examination

DISTAF treats several categories of instructional activity that are not entered on Table 1A: **review** sessions, formal **examinations**, scoring of student work, group **discussions**, and student-instructor discussions. The configurations required to carry out these activities can be derived from decisions the planner makes in using DISTAF in conjunction with the Curriculum Analysis. These decisions are discussed in Sec. V, which describes the logical structure of DISTAF in detail.

The term learning event, a key concept in system design, refers to any instructional activity that can be assigned to one of the subcategories in Table 1A. A single class session will usually contain several learning events. For example, teaching a typing skill may involve an introductory talk or discussion (Type I, scheduled, easy), the presentation of a model of performance (Type III, model of student performance, scheduled, simple), a follow-me demonstration (Type III, mixed, scheduled, simple), and a practice session (Type III, performance, scheduled, simple). If a particular instructional activity seems to be a mixture of more than one subcategory, it should be subcategorized, as in the above example. If this would result in many learning

events, each of very short duration (say less than five minutes), the activity should be assigned to the category that requires the most resource support. Generally, this is the category with the higher line number on the table. (Unscheduled study, of course, will be easily separable from scheduled instruction.)

RELATIONSHIP OF DISTAF CATEGORIES OF INSTRUCTION TO OTHER SYSTEMS OF CLASSIFICATION

At first, it would seem possible to use one of the existing taxonomies as a scheme for classifying instruction. Why was it necessary to devise a new system from scratch? The answer is that none of the major classification systems relate what is being taught to its inherent resource requirements. Hence, none can form a basis to guide the functional design and resource analysis of instructional systems.

Let us look briefly at three existing structures to illustrate this point: Bloom's *Taxonomy of Educational Objectives,*[8] Gagné's eight types of learning,[9] and the Air Force Proficiency Code for technical training.[10] Bloom's major categories of educational objectives are based on educational and psychological considerations: **cognitive**, **affective**, and **psychomotor**. Cognitive and affective categories may or may not require overt student performance and may or may not be classroom instruction. For example, cognitive skills or knowledge are used heavily in troubleshooting a jet engine (Type III instruction), in solving arithmetic problems (Type II instruction), and in gaining an understanding of the causes of the Civil War (Type I instruction). Affective objectives may also be sought in any of the three types of instruction. Only psychomotor objectives cannot be taught in Type I instruction. Handwriting, for example, is a psychomotor skill taught in Type II instruction.

Gagné's eight types of learning are based on considerations of the psychology of learning: signal learning, stimulus-response learning, chaining, verbal-associate learning, multiple discrimination, concept learning, principle learning, and problem solving. Some of these, such as problem solving, require overt student performance and hence cannot occur in Type I instruction. All of them may or may not require special facilities or equipment.

The Air Force Proficiency Code, reproduced in Fig. 3, comes closest to the categorization we use but is intended to indicate the relation of the knowledge and skills to the Air Force specialty. Therefore, it does not go far enough in subcategorization, because, for example, it makes no distinctions on the basis of level of difficulty or type or response required. Most importantly, *task performance* is not distinguished by whether or not it requires special facilities or equipment.

We grouped task knowledge and subject knowledge as Type I instruction (since they do not require student performance), although much of task knowledge can be

[8] B. S. Bloom, et al., *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain,* David McKay Company, Inc., New York, 1956.

[9] R. M. Gagné, *The Conditions of Learning,* Holt, Rinehart and Winston, Inc., New York, 1965.

[10] *Specialty Training Standard: Jet Engine Mechanic and Jet Engine Technician,* STS 43230/50/70, Department of the Air Force, Washington, D.C., 22 August 1968.

PROFICIENCY CODE KEY		
	SCALE VALUE	DEFINITION: The Individual
TASK PERFORMANCE LEVELS	1	Can do simple parts of the task. Needs to be told or shown how to do most of the task. (EXTREMELY LIMITED)
	2	Can do most parts of the task. Needs help only on hardest parts. May not meet local demands for speed or accuracy. (PARTIALLY PROFICIENT)
	3	Can do all parts of the task. Needs only a spot check of completed work. Meets minimum local demands for speed and accuracy. (COMPETENT)
	4	Can do the complete task quickly and accurately. Can tell or show others how to do the task. (HIGHLY PROFICIENT)
* TASK KNOWLEDGE LEVELS	a	Can name parts, tools, and simple facts about the task. (NOMENCLATURE)
	b	Can name the steps in doing the task and tell how each is done. (PROCEDURES)
	c	Can explain why and when the task must be done and why each step is needed. (OPERATING PRINCIPLES)
	d	Can predict, identify, and resolve problems about the task. (COMPLETE THEORY)
** SUBJECT KNOWLEDGE LEVELS	A	Can identify basic facts and terms about the subject. (FACTS)
	B	Can explain relationship of basic facts and state general principles about the subject. (PRINCIPLES)
	C	Can analyze facts and principles and draw conclusions about the subject. (ANALYSIS)
	D	Can evaluate conditions and make proper decisions about the subject. (EVALUATION)

– EXPLANATIONS –

* A task knowledge scale value may be used alone or with a task performance scale value to define a level of knowledge for a specific task. (Examples: b and 1b)

** A subject knowledge scale value is used alone to define a level of knowledge for a subject not directly related to any specific task, or for a subject common to several tasks.

\- This mark is used alone instead of a scale value to show that the individual needs no training in task performance, task knowledge, or subject knowledge at this skill level.

X This mark is used alone in ATC course columns to show that training is not given due to limitations in ATC resources.

Fig. 3—Air Force proficiency code for technical training

transmitted during the presentation of performance models in Types II and III instruction.

STRATEGY QUESTIONS

Strategy questions are asked for each instructional category included in a course. In this section we discuss only questions that apply to basic scheduled instruction[11] because this is the category for which most planning traditionally is carried out. Two criteria guided the choice of questions and answers:

- It should be possible to describe any teaching method of current interest by giving appropriate answers to the questions; that is, the questions should be comprehensive.
- It should be possible methodically to derive an instructional program that could implement the strategy described by any set of answers.

We demonstrate subsequently that each criterion is satisfied, at least in part, by the questions and answers chosen.

Whenever the designer makes a decision using DISTAF, he enters a number corresponding to his decision (as indicated in the User's Manual, Appendix B) into the computer. The computer then assigns that value to the variable corresponding to the given decision. We call this a **strategy variable**. After completing a run through DISTAF the instructional strategy becomes, in essence, a set of specific values (each value corresponding to an answer the user made to a question) that the computer assigns to variables and compiles as the user progresses through the decision process. The set of answers describes a strategy of instruction in terms that will direct instructional program design. The product of DISTAF, then, is a specified instructional **strategy**, not a specific instructional **program**. (The process for translating instructional strategies into the instructional programs needed to carry them out is still under development, as discussed earlier.)

Before proceeding, it will be helpful to recall that a major premise of the Rand work is that the content of instruction has already been determined; that is, the design process does not deal with matters of content or content emphasis. So there is no explicit treatment of such questions as: How much time should be spent on fundamentals as opposed to hands-on performance? How frequently should a skill be practiced for long-term retention? Should explicit efforts be made in the classroom to motivate student involvement with the subject by including pep talks, orientation sessions, and the like? These questions will be addressed in a systematic fashion in the future; because of the Air Force work on systemization of instruction, they are not treated here.

[11] **Basic instruction** because it is intended as the core of the learning process (assimilation of information or development of skills, depending on the subject matter), and **scheduled instruction** because it is carried out at a predetermined time and place (usually referred to as "during class hours").

Adaptive Method

For convenience, we distinguish between adaptive method and adaptive content. In general, there is no clear dividing line between the two types, although different approaches can certainly emphasize one or the other. At present, DISTAF is primarily concerned with allowing the planner to adjust the **method** of instruction to students' learning capabilities. For scheduled basic instruction, DISTAF allows the planner to specify strategy for both **between-session** and **concurrent** adaptivity. In between-session adaptivity an instructor, a computer program, or a tutor analyzes each learner's performance during previous instruction and chooses the particular technique to use for the next session of instruction. In concurrent adaptivity, the method of instruction is adjusted to each student's needs while the instruction is in progress.

The planner first designates how students are to be grouped on the basis of learning capability. This decision is heavily influenced by the analysis of the learner population that precedes the use of DISTAF. An instructional strategy is then specified for the students in each group. When making the grouping decision, the planner may treat each student as an individual, that is, adapt the instructional method to each student's learning capability.

Next, the planner designates the adaptive agent (adapter) for each group or for all individuals. The adapter may be an instructor, a student leader, the individual student,[12] or an **adaptive program**.

An adaptive program directs the student's study as he progresses through the material on the basis of his demonstrated mastery of the material. Such programs are usually presented by a computer and always involve branching of some form; that is, at certain points students are shunted along different paths depending on their reactions to the preceding material. Scrambled books or other media that indicate branching are not adaptive programs in the full sense because the user must perform the actual branching. A scrambled book, for example, will direct the reader to different pages depending on his answers to a question. The adaptive agent, in this case, is partly the book and partly the reader because he may choose not to follow the directions exactly.

If students are grouped by learning capability, DISTAF gives the planner the opportunity to specify a different adapter for each group, if desired. If students are treated as individuals, however, the adaptive agent is assumed to be the same for all students.

The rest of the variables specified if the method is adaptive are described under *Presentation*, which follows the description of **variable pacing**.

Variable Pacing

Even though the method of instruction may not be adapted to student learning capabilities in general, the rate of instruction may be matched to student learning

[12] Students who are academically sophisticated (such as graduate students) are often their own adapters.

rates. This is called variable pacing and is effected by determing whether the student has mastered each learning objective before proceeding to the next. This adjustment is always made concurrent with the instruction. (Note that variable pacing is implicit if the method is adaptive.) If the planner decides to use variable pacing in an instructional category, he chooses the controlling agent (**pacer**), which may be an instructor, a student leader, an individual student, or a **response-paced program**. A response-paced program is similar to an adaptive program except that it contains no branches and varies only the rate of presentation. Most teaching machines present response-paced programs.

The pacer may match the rate of instruction to the learning rate of a single student or to the average learning rate of a group of students. The planner may choose the latter tactic to save money if he feels enough students will have similar learning rates to group them without losing the benefits of variable pacing. If the learner is his own pacer (self-pacing), this type of grouping is not possible, of course.

The rest of the variables specified if variable pacing is used are described below under *Presentation.*

Presentation

There are six primary strategy variables: presenter, background materials, **integrated stimuli**, recording responses, type of response, and feedback to learner. Each is discussed in turn.

Presenter. DISTAF emphasizes variables that direct the design of communication media systems for instruction. Therefore, a primary variable is the presenter of information, of directions for student performance, of drill stimuli, or of a demonstration of a skill that students must master.

For basic scheduled instruction the presenter may be an instructor, a student leader, any **appropriate communication medium**, a **fixed-duration program**, an adaptive program, or a response-paced program. Some of these terms are now discussed. An appropriate communication medium is one that can convey the substance of the presentation: it is chosen for each topic from data supplied by the Curriculum Analysis.

A fixed-duration program is one whose time for presentation is not intended to be affected by the students. Anything that "runs," such as a film or audio tape, is a fixed-duration program unless special equipment is added to control running time. Fixed-duration programs simplify scheduling and are useful when students must attain some minimum speed of performance.

The adaptive program and the response-paced program are used to adapt the method or pace of a presentation by any appropriate communication medium to the students' learning capabilities. The adaptive program is an option if adaptive methods are used; the response-paced program is available for variable pacing.

If the learner is his own pacer, he must be supplied with the appropriate communication media and whatever mechanisms he may need to control them. If the medium needed is the printed page, no additional controls are required; if the medium needed is what would normally be presented by a fixed-duration program,

stop and start controls must be provided to permit the student to pace the presentation as he desires.

Similarly, if the learner is his own adapter, he must be given **internal random access** to the materials. In the case of normally fixed-duration programs, this means that the student must be able to stop, start, fast-forward, and fast-reverse the program at will and that the program must be coded so that he will know where to advance it to or back it up to.

Background Materials. Materials are provided to support (or carry the burden of) instruction except when the presenter is an instructor and the planner explicitly chooses to rely on him to gather and prepare his own materials and instructional aids, such as charts or transparencies. The planner can choose special kinds of materials to support instruction by an instructor, student leader, or learner (self-instruction). They are: a programmed guide and **stratified materials**, i.e., **modularized materials** prepared at several levels of difficulty.

Integrated Stimuli. If a student is paying attention to the instruction, he reacts to it in some way, even if his reaction consists only of temporarily recognizing a familiar phrase. To heighten the probability of intensive reaction, teachers often pose questions to students to elicit an overt response (integrated stimuli) from the student questioned directly. This usually elicits covert responses from most of the other students. If the instructional method is to be adapted concurrently to student capabilities, or if the pace is to be adapted to student learning rates, stimuli for overt student response *must* be an integral part of the instruction in order to provide the basis for branching or pacing. The choice of using integrated stimuli in other instances is left to the planner.

Recording Responses. If stimuli for overt student response are integrated with the presentation, student responses may be permanently recorded for later use. Either the student or the instructor may analyze these records to evaluate mastery of concepts or skills; recorded responses may also be used as a springboard for classroom discussion.

In many instances, the responses called for are recorded by their very nature. An obvious example is a concrete student product such as a weather map. Unless special provisions are made to record them, other responses may be ephemeral; e.g., a student's ability to pronounce foreign words.

Whether or not student responses are permanently recorded is never an automatic consequence of prior decisions; the planner must *always* make this choice. Even with adaptive or response-paced programs, which must temporarily register student responses in order to "sense" whether to go forward and to what point, permanent recording for later analysis (by machine or human) requires additional equipment.

Type of Response. We separate responses into two major categories: **constructed** and **selected**. The student himself devises a constructed response by speaking, writing, drawing, making a concrete object, checking, adjusting, repairing something, or performing some physical act such as swimming. A selected response is one the student chooses from among two or more previously prepared possibilities. To clarify the concept, consider test and measurement (although the student re-

sponses being considered for basic scheduled instruction are those that would be made to stimuli integral with the instruction, not to an examination). Examinations calling for selected responses are generally known as objective tests because subjective judgments do not enter into scoring; the answer is either right or wrong. There is no room for subjective judgment on the part of the instructor, except as it influences his choice of the response to be accepted as correct. Test items in these examinations are typically multiple-choice, true-false, matching, or ordering.

In many instances it is impossible to assess student mastery of a particular subject by eliciting a selected response. A performing skill such as playing the oboe demands that the student be able to perform, not that he merely recognize acceptable performance or be able to list the aesthetic principles of good performance. But it is also possible that selected responses can be used to assess student mastery of other skills, such as computation or reading. Thus, although constructed responses may well be required to assess student mastery of some subjects, they may be optional for others. DISTAF provides the planner with the flexibility he needs in making this choice.

The distinction is significant for system design. Because selected responses are chosen from a restricted set, they can be coded for recognition by simple teaching machines or by computers. However, only special computers now being developed can "recognize" constructed responses, and these responses must usually fall within a narrow range such as block letters, a small number of spoken words, or a special computer language. Even in these instances, the computers are relatively expensive. In the current version of DISTAF, we simply assume that only selected responses can be used for machine recognition or scoring.

Stimuli calling for constructed response are easy to write, but scoring them takes time and skill. Scoring selected responses is simple and can even be done by machine. Once the material is written, many students may use it without adding the heavy burdens of grading papers on the instructor. Item analyses and other techniques can be applied to determine test reliability, and so on, but a considerable amount of skill is required to prepare good stimuli calling for selected response. Almost everyone has had the experience of feeling that a particular statement was neither true nor false and wondering how to outguess the test writer in choosing the proper designation. In addition, some skills, such as proving trig identities, may be very difficult to evaluate by calling for selected response, and some may be impossible, such as disassembling and reassembling a pump.

Feedback to Learner. After the learner has had time to respond, he may be shown or told whether his answer was acceptable. This information can be provided in a variety of ways: an instructor or other judge can give it on the spot, the student can be shown a model of an acceptable response, or the action of a machine can indicate whether or not the response was correct. Although many educators believe that such feedback enhances learning, experimental results are inconclusive. In any event, feedback to the learner is mandatory in any self-directed study.

RELATIONSHIP OF ANSWERS TO STRATEGY QUESTIONS TO CURRENT TEACHING METHODS

A primary goal of the DISTAF process is to permit the planner to "capture" any method of instruction of interest to him in terms that will direct system design. This section demonstrates the extent to which this goal has been reached to date by relating several instructional methods of current interest to sets of values of the DISTAF strategy variables. It also shows that DISTAF permits the specification of many instructional methods that are not part of most educators' repertoire.

The Air Force has issued a number of useful publications describing various aspects of instruction. Air Force Manual 50-9, *Principles and Techniques of Instruction,* for example, lists the following under teaching methods: demonstration-performance, guided discussion, case-situation (sometimes called role playing), lecture, team teaching, the field trip, the laboratory, socialized recitation, and programmed instruction. To this list we might add: tutoring, peer tutoring, computer assisted instruction (CAI), individualized instruction, and the Socratic method. In general, we believe that the requirement for some of these methods should be a consequence of higher-order design decisions, rather than a need stated at the outset.

To discuss how these methods are related to sets of values of strategy variables, we must extract their essential characteristics as they relate to instructional system design. First, we note that several of the methods are essentially different from the others in that they specify use of some *element* of the instructional system (such as materials, equipment, facilities, or personnel) rather than a *procedure* for using such elements. These are: team teaching, the assignment, the field trip, the laboratory, and possibly CAI, although CAI also has special implications for procedure. Team teaching is primarily a method of assigning teachers to classes and usually implies modularized scheduling; that is, breaking class periods into small units of, say, 15 minutes each to permit flexibility of scheduling. This technique has not explicitly been included in DISTAF to date, as it levies special requirements on the school for data processing, facilities, and staffing. The assignment corresponds to the DISTAF category of unscheduled study and can be fairly fully treated by the designer. Similarly, the field trip and the laboratory refer to instruction that takes place in special facilities, that is, Type III instruction.

Next, the remaining methods are grouped according to their requirements for overt learner activity and interactions with other learners.

1. *Minimal learner activity*—Lecture and lecture-forum. We group these together because we assume that almost any lecture will be followed by or interleaved with a "forum" (class discussion) of some kind.
2. *Learner interaction with instructional agent but not other learners*—Recitation, the Socratic method, tutoring or peer-tutoring, programmed instruction, and individualized instruction. These methods all elicit overt learner responses during the instruction and can be used in a one-to-one (teacher-learner) situation. Recitation, the Socratic method, and programmed instruction can also be used in a group (one-to-many) mode.

3. *Learner interaction with instructional agent and other learners under instructor direction*—Guided discussion. This method elicits overt student responses during instruction but requires a group situation.
4. *Learner interaction with other learners, instructor direction not required*—Role playing, dialogue, panel, symposium, dramatization. These are all Type II, interactive skills. In most cases, the activity would be preceded by a description of what is expected or a model of performance, and preparatory assignments for unscheduled study, followed by a discussion or summary by the instructor. Both the preceding and succeeding activities would be classed as separate learning events.
5. *Learner performance, minimal direct instruction*—Demonstration-performance. In technical training this is probably the most common type of instruction. As the term implies, it usually involves at least two learning events: the presentation of a model of performance, and actual student performance. The latter may be for development of either individual or interactive skills.

Table 2 traces the choices that a designer would make in using DISTAF if he wanted to specify one of the five methods listed above in a form in which its use is generally understood. Note that the second column identifies the categories of instruction to which the method is usually applied. This designation is an integral part of specifying the method. A brief discussion of the instructional methods listed in Table 2 follows.

Lecture

The lecture method applies to scheduled Type I instruction or to scheduled presentation of models of performance in Types II or III instruction for either an individual learner or a group of learners. To specify it, the designer first indicates that no adaptive method and no variable pacing would be used. That is, approximately the same content would be delivered in the same way and in the same amount of time, regardless of variations in learner capabilities. He then would choose the instructor as the presenter and indicate that stimuli for overt student response would not be integrated with the presentation. This decision automatically implies that the instructor will not receive programmed materials and that the learner will not receive immediate feedback regarding the correctness of his response (because he has made none). The designer can supply background materials to the instructor as he sees fit.

Recitation

Recitation applies to Type I instruction and to some student performance in Type II instruction, such as practicing pronunciation, and can be used in either the group or individual mode. To specify it, the designer chooses to integrate stimuli

Table 2

RELATIONSHIP OF ANSWERS TO STRATEGY QUESTIONS TO CURRENT TEACHING METHODS

Method	Categories of Instruction	Adaptor (Adaptive Method)	Pacer (Variable Pacing)	Presenter	Integrated Stimuli	Programmed Materials	Background Materials	Immediate Feedback to Learner
Lecture	Scheduled: Type I; Types II and III (model of performance)	None	None	Instructor	No	(No)	O[a]	(No)
Recitation	Scheduled: Type I; Type II (performance)	None	None	Instructor	Yes	No	O	O
Socratic	Scheduled: Type I	Instructor	(Instructor)	Instructor	(Yes)	No	O	Yes
Tutor	Scheduled: All	Instructor	(Instructor)	Instructor	(Yes)	No	O	Yes
Peer-tutor	Scheduled: All	Student-peer	(Student-peer)	(Student-peer)	(Yes)	No	(Yes)	Yes
Programmed Instruction								
Linear								
Teaching machine	Type I; Types II and III (performance with selected response)	None	Response-paced program	(Communication medium)[b]	(Yes)	(Yes)	(No)	(Yes)[c]
Self-pacing	Type I; Types II and III (performance)	None	Learner	(Communication medium)	(Yes)	(Yes)	(No)	(Yes)
Branching								
CAI	Type I; Types II and III (performance with selected response)	Adaptive program	(Adaptive program)	(Communication medium)	(Yes)	(Yes)	(No)	(Yes)[c]
Individualized instruction	Type I; Types II and III (performance)	Learner	(Learner)	(Communication medium)	(Yes)	(Yes)	(No)	(Yes)
Guided discussion	Scheduled: All	Instructor	(Instructor)	Instructor and learners	Yes	No	O	O
Interactive activities[d]	Scheduled: Type II (performance)	Learners	(Learners)	None	(No)	No	O	O
Demonstration-performance								
Demonstration	Scheduled: Types II and III (model of performance)	None	None	Instructor	No	O	No	No
Performance	Scheduled: Types II and III (performance)	None	None	Instructor	O	O	O	O

NOTE: A choice in parentheses is a logical consequence of another choice on the same line, as discussed in the text.

[a] O = Optional.

[b] Any appropriate communication medium.

[c] The action of the machine provides feedback.

[d] This line applies to such activities as dialogue, panel, symposium, and dramatization.

with the instructor's presentation. Again, the designer can provide the instructor with background materials and expect (or direct) the instructor to provide immediate feedback to the learner(s) regarding the correctness of his (their) responses as they are made. These background materials would not be "programmed" in the usual sense that a student's progress from item to item would depend on his demonstrated mastery of the items, although most instructors would use crude approximations of programming during a recitation session, such as repeating items for which responses were poor or skipping items that students obviously know.

Socratic

The Socratic method applies to Type I instruction. The instructor asks questions of the learner or group and frames succeeding questions to the learner(s) on the basis of his (their) replies in an effort to elicit from them what they have learned. The designer would therefore choose an adaptive method (which implies variable pacing), with the instructor as presenter and adapter. Stimuli *must* be integrated with the presentation because the method is adaptive, and learner(s) must receive immediate feedback. The designer would not supply the instructor with programmed materials because these would destroy the ad hoc nature of the method. The designer may choose whether or not to supply the instructor with topic materials.

Tutor

Tutoring, used for all types of instruction, is considered as scheduled instruction rather than unscheduled because of the difficulties associated with coordinating the joint participation of tutor and learner at odd hours. The tutor is an adapter of instruction and, hence, paces the individual learner's progress as the tutor presents the items to be mastered. Stimuli must be integrated, of course, and the learner receives immediate feedback. The designer has choices about whether to supply the instructor with topic materials. Like the Socratic method, tutoring implies a large amount of ad hoc adaptivity, and supplying programmed materials undoubtedly would defeat its purpose.

As the table suggests, the Socratic method when applied in the individual mode is similar to tutoring. The primary difference lies in the extent to which the instructor presents what is to be learned. With the Socratic method, the learner is expected to bring enough background to the session that the subject matter can, in essence, be drawn out of him by astute questioning. With tutoring, the tutor presents as much or as little of the subject as seems warranted by the learner's responses. Thus, the Socratic method might well call for preparatory assignments; tutoring would contain a larger fraction of presentation.

Peer-Tutor

The decisions for the peer-tutor are similar to those for the tutor except that a

learner's peer is the adapter of instruction; he must be provided with lesson materials, it being unreasonable to expect a student to acquire these himself.

Programmed Instruction

We touch on two types of programmed instruction: linear and branching. Both may be used for all types of instruction. To select linear programmed instruction, the designer would use variable pacing. To select branching programmed instruction, the designer would use the adaptive method. Either choice automatically requires that stimuli for overt student response be integrated with the instruction.

Linear Programmed Instruction

Teaching Machines. The majority of teaching machines present response-paced programs, and this is the application referred to here. Such teaching machines can be used throughout Type I instruction and in Types II and III instruction wherever student progress can be checked by eliciting selected responses. Instruction may be either scheduled or unscheduled, but if unscheduled, usually the learner must work in a carrel or other special facility. Programmed materials must be provided for the machine in a communication medium. Background materials are needed only in the preliminary stages of the programming and are not supplied to each machine. A limited form of immediate feedback to the learner regarding the correctness of his responses is supplied automatically by the response of the machine, although the learner does not know why his answer was right or wrong.

Self-Pacing. This method puts the learner himself in the role of the pacer. He must be supplied with programmed communication media (programmed text or a teaching machine that is not response-paced) that provides immediate feedback on the correctness or acceptability of his responses so that he knows how to pace himself. As before, background materials are not needed for each learner. Responses may be either selected or constructed.

Branching Programmed Instruction

CAI. As with the term teaching machines, the term CAI has many interpretations and implies the use of various instructional methods. Computers can use adaptive programs[13] to branch students along different paths, contingent on their responses to stimuli. As with linear programmed instruction, only selected responses can be used in this way. An adaptive program also paces the instruction and uses a communication medium to present the instruction. Other choices and consequences are the same as for the teaching machine using a response-paced program.

Individualized Instruction. This term can also refer to any of several combi-

[13] Use of computers for linear programmed instruction is generally considered wasteful, as the much less expensive teaching machines and other response-pacing devices do as well.

nations of values of DISTAF strategy variables. Many individualized systems are, in fact, combinations of programmed instruction (either linear or branching) and various degrees of adaptivity of course content, the most common type being to adapt content to student prior learning as determined by a diagnostic pretest. Some individualized instruction also includes individually prescribed learning objectives that are not part of the basic course; usually these represent only a small fraction of the student's total course of study. DISTAF's provisions for enrichment and remedial topics could easily be used for this purpose. DISTAF also offers many possibilities for taking account of student learning capability or style in planning and carrying out instructions.

The individualized instruction shown on the table puts the learner in the role of adapter (and hence pacer) of instruction. Other choices and consequences are the same as for self-pacing.

Guided Discussion

Guided discussion requires an instructor to direct a group of students; hence, it is scheduled instruction. It can apply to subjects taught in all categories of instruction and can be designated by answering "yes" to questions on discussions scheduled during class hours. Discussions intended primarily to develop such social skills as communication, leadership, and listening (rather than reviewing and exploring previous work) are scheduled Type II instruction, interactive skills.

A guided discussion requires the instructor to adapt and pace the instruction for a group of students. Because the students themselves are expected to contribute to the discussion, they are presenters, along with the instructor. Stimuli for student response must be integrated with the instruction, of course, but programmed materials would destroy the spontaneity of the discussion. Background materials might be provided, and learners might be given immediate feedback, at the designer's and instructor's discretion.

Interactive Activities

Dramatization and similar interactive activities are scheduled Type II instructions involving student performance. (These activities have been grouped because their requirements for resources are about the same.) The students assume more responsibility for adapting the direction and pace of the activity than in guided discussion, stimulate each other, and usually tell each other when responses are particularly apt or inept. At the designer's option, materials such as rules of play, directions, references for preparation for panel discussions or for writing backup papers may or may not be supplied. Usually activities such as role playing are preceded by a preparatory learning event and followed by some kind of discussion or critique.

Demonstration-Performance

Demonstration-performance, as described in Air Force Manual 50-9, is a structured activity used in Types II and III instruction under close supervision by an instructor. The instructor demonstrates the performance the students will subsequently practice. He then provides initial directions for their performance, supervises it closely, giving directions and commenting on the work as it proceeds, and follows the session with a critique. At the other end of the spectrum, however, it would be possible for an instructor simply to give initial instructions and leave. Students could check their progress from models or by talking to each other. These options are indicated in the table.

IV. EFFECTS OF INSTRUCTIONAL STRATEGIES ON SYSTEM DESIGN

The final design process integrates the Curriculum Analysis and the DISTAF output to describe an instructional system in terms of student flows and time-dependent requirements for resources. This section shows how responses to the DISTAF decision points, interacting with data from the Curriculum Analysis, provide guidelines for this process. First, the determinants of student flow are treated, as many resource requirements depend directly on the number of students to be taught. Next, variable values that directly affect requirements for instructors and other teaching staff are described. Then values that directly affect requirements for teaching materials, instructional aids, and equipment are similarly discussed. The section ends with a table summarizing the effects of the strategy variables on system design.

STUDENT FLOW

The flow of students through a course generates requirements for resources of all sorts—instructors, facilities, materials, equipment, and, if students are supported by the teaching institution, student pay—as well as determining the rate at which students graduate. Many DISTAF variables were chosen to permit precise description of the way student flow is related to resource requirements. Student flow is, in essence, determined by three main items: the amount of material each student must learn, the regular class time to set aside for basic scheduled instruction, and student learning rate.

Decisions Affecting the Amount of Material Each Student Must Learn

The Curriculum Analysis provides the basic description of the amount of material each student must learn. This information may be modified in light of

decisions made in stating general policy so that course content can be adapted to student background or learning capability or both. At this point, DISTAF asks the planner to indicate what means he will use to place students in the proper categories, by typing 1, 2, or 3. If he types 1, in the model of student flow, students are tagged as belonging to one or another category on the basis of general information on their background available when they enter the course; if he types 2, assignments are made after an initial tryout period in the course; if he types 3, assignments are made on the basis of a diagnostic pretest. In effect, he assigns the value 1, 2, or 3 to the strategy variable A(76).[14] From this point on, students receive the modified course appropriate to the category assigned them and are placed in the appropriate track or group if these are formed.

Decisions Affecting the Regular Class Time Set Aside for Basic Scheduled Instruction

Students may be expected to do a significant amount of learning outside of regular class hours, that is, during unscheduled study. As more of the basic material is designated for unscheduled study, student flow increases, presuming that students can master the materials on their own. Learning events for unscheduled study are so designated in the Curriculum Analysis.

Unscheduled study can generate instructional activities during regular class hours, however, such as checking and discussing the assignment. If regular class time is devoted to such activities, _(73)[15] indicates the number of minutes required, on the average. This time is then added to scheduled instruction following unscheduled study.

Basic scheduled instruction can generate similar requirements for additional time during regular class hours. If an instructor or student leader does not present the instruction, it is possible that the planner will want to set aside some class time for students to discuss the instruction with each other or with the instructor [A(18) =1]. In that event, A(12) gives the percentage of time in basic instruction to set aside for discussion sessions and A(77) determines the frequency with which these sessions will occur.

If the students discuss material presented by a communication medium with a monitor or instructor during the presentation [A(17)=2], it adds 5 to 10 minutes to the presentation time, with a resultant effect on student flow.

Similarly, if the instruction requires students to make overt responses, the planner may decide to use these responses as a springboard for class discussion by setting aside class time for scoring the responses [A(58)=1].

Formal examinations regulate student flow and also take time during regular class hours. The specification of the frequency of examinations at all levels from

[14] Strategy variables used in this report are defined in Appendix D.

[15] The notation "_(00)" indicates that there is more than one variable with this subscript because the value is determined for more than one category of instruction. This case includes Type I instruction and simple and complex Type II instruction.

quizzes to finals is denoted by variables e(1,i) or e(2,i).[16] Variables e(19,i) or e(20,i) denote the average length of each type of examination.

If students are academically mature, reviews before examinations are frequently assigned for unscheduled study [e(12,i)=0 or e(14,i)=0]. Scheduling reviews [e(12,i)=1 or e(14,i)=1] decreases the rate of student flow, but may also decrease the failure rate. The number of minutes devoted in class to each type of review is designated by e(16,i) or e(18,i).

Finally, the method of presenting the instruction also affects the amount of time spent during regular class hours. Instruction presented by a live instructor or tutor [_(6)=1 or 3, _(19)=1 or 3, _(50)=1 or 3, _(61)=0, A(97)=1] may ramble or miss important points, thereby requiring retracing of part of the material, or simply be poorly organized and confusing to the student. It is generally conceded that using communication media for instruction can decrease learning time by forcing the attention and resources on planning and production that are needed for efficient communication.

Decisions Affecting Student Learning Rate

The Curriculum Analysis provides the basis for deriving the student learning rate. In it, the planner estimates the time required for each learning event in conventional instruction. This time usually reflects the learning rate of students with somewhat below average ability. In many schools, the subject matter is presented on a fixed schedule; i.e., every student is supposed to be studying approximately the same content at the same time [A(53)=1]. Students may drop out of a course at specified points, however; the percentages of students leaving at each point will vary. Or students may recycle through a part of the course if they fail the examination covering that part or have had excessive absences; again, the recycling rate will vary for different parts of the course.

To accommodate to wide ranges in student learning capabilities, many schools have introduced methods that permit students to proceed through course content along different paths [A(1)=2 or A(1)=1 and _(54)≠0] (adaptive instruction) or at different rates [A(2)=1 or A(2)=2 and _(14)≠0] (variable pacing). Adaptive instruction always implies some type of variable pacing, depending on the type of adaptivity used. Generally, in such systems the average student finishes the course in less time than would have been allotted for fixed-schedule instruction, partly because fixed-schedule instruction tends to adjust to the slower student's learning rate and partly because the opportunity to finish the work sooner motivates most students to learn faster. To add or enhance motivation for rapid progress through the course, a number of educators have advocated the use of incentives—material rewards for completing topics or units of subject matter [e(25,1)=1]. Rewarding students by giving them time during class hours when they are free to use recreational facilities and

[16] The choice between the two variables depends on the basis for scheduling examinations; that is, whether it is calendar time or course content.

the like is also used as an incentive [A(28)=1]. To some extent, this may reduce the rate of student progress through the course.

Adaptive instruction or variable pacing may be used within a "fixed" schedule by requiring each student to be at the same point in the course at designated times, such as just before major examinations or at the beginning of each day, but allowing students to proceed at their own pace within these limits. Alternatively, the schedule may be completely free, with only an upper limit set on the time an individual student may spend in the course.

Student learning rates are also affected if students are put into tracks or groups [__(54)≠0] on the basis of their capability. This technique probably tends to lower the average rate of progress to some extent, although students in above-average groups or tracks will still progress faster than those in below-average groups or tracks.

A similar tactic may be used when the only adaptivity is to adjust the rate of instruction, if students are grouped by learning rate [__(80)≠0]. This is a particularly useful device if the Curriculum Analysis designates learning events that require students to interact with one another, as in work teams, sports, or role playing. Such requirements are easily met in a fixed-pace course; but if the course were individually paced, a student might have to wait until enough other students have caught up with him to form the group of the required size, designated in the Curriculum Analysis. Variable pacing of groups of students that have nearly the same learning rates allows the planner to meet the need for interactive groups and still realize most of the benefits of variable pacing.

PERSONNEL

Because teacher salaries are a major (or *the* major) cost of instruction in most schools, DISTAF emphasizes variables that affect personnel requirements. These are directly affected by the number of tasks assigned, their frequency and length, and the ratio of students to employed personnel for each task. In general, student/personnel ratios depend upon specific requirements (as for safety monitoring) stated in the Curriculum Analysis or upon the facilities available. Some of the DISTAF variables affect student/personnel ratios indirectly. These are mentioned during the following discussion.

Table 3 displays tasks that may be assigned to instructors, student instructors, or clerks. Generally, the frequency and length of these tasks may be determined from Curriculum Analysis data; instances in which they are not are noted.

If an instructor presents basic instruction during class hours, as in the first three tasks listed, the Curriculum Analysis gives the frequency directly. The time required for presentation (task 3) is also given directly; for tasks 1 and 2, student learning rate affects time, which must be derived by simulating student flow. Student/instructor ratios are indirectly affected by any tracking or grouping used

Table 3

VALUES OF VARIABLES RELATED TO PERSONNEL REQUIREMENTS

Tasks	Determinants of	
	Frequency	Length
1. Adapt basic instruction: __(63)=1 and __(6)=1	C.A.[a]	C.A.
2. Pace basic instruction: __(14)=3 [__(63)=0]	C.A.	C.A.
3. Present basic instruction: __(6)=1 [__(14)=0 and __(63)=0]	C.A.	C.A.
4. Discuss media presentations during presentation: A(17)=2	C.A.	C.A.
5. Monitor media presentations: __(78)=1 or 2	C.A.	C.A.
6. Present Type I instruction requiring special facilities or equipment: __(61)=0	C.A.	C.A.
7. Present models of student performance: __(50)=1	C.A.	C.A.
8. Present follow-me demonstrations: __(19)=1	C.A.	C.A.
9a. Discuss media presentations after presentation and during class hours: A(18)=1	C.A. & A(77)	A(19)
9b. Discuss media presentations after presentation and outside of class hours during work day: A(18)=2	C.A.	A(19)
10. Check homework in class: __(73)≠0	C.A.	__(73)
11. Present reviews and examinations: __(55)=0 and __(6)=1 or 3	e(1,i) or e(2,i)[b] e(12,i) or e(14,i)[b]	e(19,i) or e(20,i)[b] e(16,i) or e(18,i)
12. Proctor examinations: e(26,i)=1 or 2 or e(27,i)=1 or 2[b]	e(1,i) or e(2,i)[b]	e(19,i) or e(20,i)[b]
13. Present remedial instruction: A(97)=1; or A(64)=1, A(97)=0 and __(6)=1	C.A.	A(96)
14. Score exams outside of class but during work day: A(51)=1	e(1,i) or e(2,i)[b]	scoring formula
15a. Score student work in class: A(58)=1	C.A.	A(19)
15b. Score student work outside of class but during work day: A(59)=1 or A(10)=2	C.A.	scoring formula

[a]Determined directly from Curriculum Analysis.

[b]Choice of variable depends on basis of examination schedule.

[_(54)=0 or _(80)=0] and are also affected by requirements for interaction with the students levied by adaptive instruction or variable pacing.

The frequency and time required for discussing media presentations during the presentation (task 4) or, if this is not to be done, simply monitoring media presentations (task 5) can also be derived from the Curriculum Analysis. Task 4 adds 5 to 10 minutes to the presentation and requires a relatively low student/staff ratio (say 10/1) unless the instructor can handle several groups at once through a communication medium. This possibility is permitted if the instructor or monitor is not required to be accessible continuously during the presentation [A(22)=0].

For tasks 6 to 8, the instructor demonstrates a concept in a special facility or by using special equipment or demonstrates a skill that students will subsequently master. Again, the Curriculum Analysis gives the frequency and time required for these tasks and also indicates the maximum number of students who may view the demonstration at one time.

Task 9 sets aside a special time for discussing media presentations after the presentation, either during class hours [A(18)=1] or outside of class hours but during the instructor's working day [A(18)=2]. The frequency of these discussions is determined by the frequency and length of media presentations; the length of discussion sessions, indicated by A(12); and the guidelines for determining when enough discussion time has accumulated, indicated by A(77).

If assignments for unscheduled study (homework, task 10) are checked in class [_(85)=1], the time required for this [_(73)] is added to the instructor's duties following each assignment listed in the Curriculum Analysis.

The instructor may present reviews and examinations (task 11) if the printed page is not the only medium used [_(55)≠0] and an instructor or student leader [_(6)=1 or 3] presented the basic instruction on which the students are to be evaluated. There will be an exception to this rule for examinations (only), however, if the final system design includes media systems that would be appropriate for the instruction for which _(6)=1 or 3. In that event, the media system replaces the instructor for presenting the examination. The frequency and length of task 11 depends on the examination requirements, the related review requirements, and the values of _(6) for learning events on which students are evaluated.

The frequency and length of task 12 is derived directly from the examination schedule.

An instructor presents remedial instruction (task 13) during his working day if A(97)=1 or if A(64)=1, A(97)=0, and _(6)=1. The Curriculum Analysis designates learning events that are above average in difficulty, and remedial sessions of the length indicated by A(96) will be scheduled into the instructor's workload.

Tasks 14 and 15 allocate instructor time for scoring[17] examinations (task 14) and scoring class work (task 15). Research on test and measurement suggests that formulas can be used as a rough guide to the time required to score essay or objective tests. These formulas are applied to tasks 14 and 15b. The frequency of task

[17] E. F. Lindquist (ed.), *Educational Measurement*, American Council of Education, George Banta Publishing Company, Menasha, Wisconsin, 1951.

14 depends on the examination schedule, of course. Task 15 is generated by student work recorded during basic instruction for which answers are not supplied to the students [_(8)=1 and _(29)=0]. If student work is scored in class, the time required will be similar to that required for discussion [A(12)].

Two variables can apply either to an instructor or to someone of lower rank such as a student instructor or a teacher's aide. These are the monitor for media presentations (task 5) and the proctor for examinations (task 12). Two other variables, excluded from the table because they are not task-related, have similar implications for personnel. They are the variables that allow the planner to specify special instructors for students in a slow track [e(21,1)=1] or a fast track [e(21,2)=1].

MEDIA MATERIALS AND PROGRAMS, AND INSTRUCTIONAL AIDS

Requirements for media materials and programs, and instructional aids depend on factors similar to those that determine personnel requirements, viz., the tasks to be done, their frequency and length, and the number of students who may view a single display (this is always 1 if the medium is the printed page). Some additional considerations relating to the cost of the initial production are also treated.

Table 4 parallels Table 3, showing the tasks, the determinants of frequency and length, and factors bearing on the initial production cost. As before, the number of students who may view a single display is suggested only roughly by DISTAF output. Other factors must be considered before these numbers may be determined more exactly.

Communication media play a direct role in adapting instruction to student capability (task 1) if the adapter is either the learner himself or an adaptive program. The Curriculum Analysis determines the frequency and length of learning events that use adaptive methods. Because the method is adaptive, branching is required, which means that the amount of material or program that must be produced will be at least doubled. The requirement for branching programming means that stimuli for overt student response must be integrated with the presentation; this, in itself, lengthens the production process and further increases production costs. Finally, if correct answers must be supplied along with the presentation, as they must if the learner is the adapter, additional presentation of answers or remedial instruction is required. This can be considerable in Type II complex instruction or in Type III instruction, in which a model of an acceptable product may have to be depicted.

The number of students who can view and interact with a given media presentation depends in part on whether tracking or grouping is used, i.e., if _(54)≠0 or 4. If _(54)=4, instruction is completely individualized, and only one student may use any set of materials or programs at one time, although dial-access systems may allow time-sharing of materials. The number of distinct sets of materials required will also be determined in part by _(54). Media system design may be different for each track

Table 4

VALUES OF VARIABLES RELATED TO MEDIA MATERIALS REQUIREMENTS

Task	Determinants of		Variables Affecting Cost of Production	
	Frequency	Length	Variable	Meaning
1. Adapt basic instruction: __(63)=2 or 3	C.A.[a]	C.A.	__(7)=1	Branching required. Stimuli for overt student response integrated with program.
			__(29)=1	Answers provided with presentation
			__(54)=x	number of distinct sets of programs required determined by value of x.
2. Pace basic instruction: __(14)=2 or 4, [__(63)=0]	C.A.	C.A.	__(7)=1	As above.
			__(29)=1	As above.
3. Present basic instruction: __(6)≠1 or 3, [__(14)=0 and __(63)=0]	C.A.	C.A.		See text.
4. Present Type I instruction requiring special facilities or equipment: __(61)=1	C.A.	C.A.	__(63)≠0	Adaptive instruction: branching.
			__(14)≠0	Variable pacing: integrated stimuli.
			__(29)=1	Answers provided with presentation.
5. Supply background materials for student leader or instructor: __(63)=1 or 4, __(21)≠0	C.A.	C.A.	__(29)=1	Answers provided with presentation.
			__(21)=2	Stratified materials required.
__(14)=1 or 3, __(21)≠0			__(16)=1	Programmed guide required.
__(6)=1 or 3, __(21)=1				
__(50)=1 or 3, __(52)=1				
[A(97)=1 and __(21)≠0] or			__(21)=2	As above.
[A(97)=0 and __(6)=(1 or 3) and __(21)≠0]			__(16)=1	As above.
__(19)=1 or 3, H(62)=1				
6. Present models of student performance: __(50)=2 or 5	C.A.	C.A.		
7. Present follow-me demonstrations: __(19)=2 or 5	C.A.	C.A.		
8. Present assignments for unscheduled study: __(45)≠0	C.A.	C.A.	__(39)=1	Stimuli integrated with presentation.
			__(46)=1	Answers provided with presentation.
9. Present reviews: __(55)=1 or __(55)=0 and __(6)≠1 or 3	e(12,1) or e(14,1)	e(16,1) or e(18,1)	e(15,1)=1 or e(17,1)=1	Special materials will be prepared for review sessions.
			e(3,1) or e(4,1)	The learning events to be reviewed.
10. Present exams: __(55)=1 or __(55)=0 and __(6)≠ or 3	e(1,1) or	e(19,1) or e(20,1)	__(23)	Amount of "objective" test to be prepared.
			e(3,1) or e(4,1)	The learning events to be tested.
11. Give diagnostic pretest: A(76)=3	Beginning of course	1 hour		
12. Present remedial instruction: A(64)=1, A(97)=0, and __(6)≠1 or 3	C.A.	A(96)		See task 1.
or A(64)=2	C.A.	C.A.		

[a]Determined directly from Curriculum Analysis.

or group, and different amounts and types of materials may be required for each, depending on the subsequent strategy and the Curriculum Analysis.

Similarly, communication media play a direct role in matching the pace of instruction to student learning rate (task 2) if the pacer is either the learner himself or a response-paced program. Production costs increase over those of conventional production because of the additional time required to prepare linearly programmed materials. As before, the requirement for providing correct answers can add considerably to production requirements in Type II complex instruction. Again, the number of students who can use a given program at one time depends in part on whether students are grouped by learning rate [__(80)≠0] or whether rates are determined individually.

The least expensive production applies to task 3, which requires only presentation, with no integrated stimuli or correct answers. The planner may, however, include these items if he wishes, even though he is not using branching or linear programming. Also, the Curriculum Analysis may indicate that the presentation requires the use of special equipment, or must take place in a special facility, or may involve more than one person, as in demonstrating a team sport. Each of these adds to the cost of initial production.

A special instance of the above appears in task 4, which is assigned to a communication medium if special facilities or equipment are needed to make a presentation that an instructor would otherwise make in Type I instruction. Since this case can arise in either adaptive instruction, variable pacing, or fixed-pace instruction, considerations of the production costs are the same as those appropriate to tasks 1, 2, or 3.

Task 5 is a catchall for instances in which an instructor or student leader is the adapter [__(63)=1 or 4], pacer [__(14)=1 or 3], presenter [__(6)=1 or 3], demonstrator [__(50)=1 or 3], or presenter of remedial instruction [A(97)=1 and __(21)=0, etc.] In each case, if the variable following the comma in the list describing task 5 has the value shown, special background materials, including instructional aids, must be supplied to the instructor or student leader. As before, the production costs are affected by a decision to supply the presenter with correct answers. With adaptive instruction [__(63)=1 or 4], the background materials may be modularized and prepared on three or four levels of difficulty [__(21)=2] (stratified materials), further increasing the skill and time required (and hence the cost) to produce them. Similarly, with variable pacing [__(14)=1 or 3], a programmed guide may be required [__(16)=1]. These choices are also applied to the background materials prepared for remedial instruction, as appropriate.

Communication media present models of student performance, follow-me demonstrations, and assignments for unscheduled study if __(50)=2 or 5, __(19)=2 or 5, or __(45)≠0 (tasks 6, 7, and 8). The printed page presents reviews and examinations if __(55)=1. If __(55)=0, these learning events are presented by whatever means was used in the original instruction. If this was a communication medium [__(6)≠1 or 3], it presents the review and examination. The frequency and length of these presentations is specified by the "e" variables shown in Table 4 for tasks 9 and 10.

The Curriculum Analysis identifies learning events on which student mastery will be evaluated in formal examinations. By specifying whether an examination will cover only the material presented since the last examination of the same type, or whether it will be more comprehensive, e(3,i) or e(4,i) identifies the learning events to consider as candidates for evaluation and specifies the requirements for media to assure that each candidate event can be evaluated, if so desired.

Communication media are used to present remedial instruction in scheduled sessions if A(64)=1, A(97)=0, and __(6)≠1 or 3 (task 12). Of course, media are required if remedial assignments are made for unscheduled study [A(64)=2]. The Curriculum Analysis determines the frequency of remedial sessions in which particularly difficult learning events are noted. A(96) estimates the length of scheduled remedial sessions; the length of unscheduled remedial assignments is determined from the Curriculum Analysis in which such assignments must be described.

EQUIPMENT

The equipment discussed below is largely that required for the appropriate communication medium needed for the instruction. Wherever a variable value directly affects requirements for media materials and programs, it usually affects equipment requirements. If the materials are explicitly designated "background materials and instructional aids" [__(21), __(52), and A(99)], the instructor or student leader uses communication media for only preparing and supporting his presentation, and little equipment is required.

A few other types of equipment designed specifically for instructional use are also treated. Training devices or actual hardware that students would operate or work with are excluded, since they cannot trade off with instructors.

There is a special implication for equipment if the learner adapts instruction for himself [__(63)=3]. He must have complete freedom in using the media; that is, he must be able to skip forward or backward, go fast or slow, stop or start as he wishes. We term this capability internal random access. It must be provided whenever the learner will be using communication media adaptively: scheduled instruction [__(6)=2 or 5], follow-me demonstration [__(19)=2 or 5], presentation of models of performance [__(50)=2 or 5], presentations in Type I instruction requiring special facilities or equipment [__(61)=1], unscheduled study [__(45)=2 or 5], or remedial instruction [A(97)=0]. The program has to be coded so that the learner knows to what point he wishes to skip or return. The printed page automatically provides internal random access. Since many subjects cannot be effectively transmitted via the printed page, however (such as the sound of a missing engine), the requirement for internal random access of otherwise fixed-duration media may be significant in many courses. If internal random access is provided __(48)=1.

A similar requirement applies if the learner is his own pacer [__(14)=2], although the only additional equipment needed for this is a stop-and-start control for the program.

Three kinds of programs with equipment that exercise various degrees of control may be specified: adaptive, response-paced, and fixed-duration. Each has special equipment requirements. Equipment for the first two must be able to stop the program to wait for student response, sense the response, and react to the response in a precoded way. Usually a computer is required to present an adaptive program, but many simple teaching machines may be response-paced. The fixed-duration program simply requires something on which it can be run—a movie projector, tape player, or television set, for example.

A special difficulty arises if any of these programs is used for unscheduled study. Most teaching machines and all computers are too bulky or too expensive for students to carry them to the dormitory or the library for unscheduled study. This means that a learning center or other facility for the students must be equipped with carrels and the needed hardware, or remote access must be provided via some electronic distribution system. Portable cassette players for audiotape are becoming less expensive and more durable. In the future they may be checked out for unscheduled study or required of each student as textbooks are.

If student responses are recorded [__(8)=1 or __(47)=1], special equipment may be needed where recording is not inherent in the kind of response being made. Student performance of skills requiring body movements, such as loading an aircraft, or interacting with others, such as following commands, can be recorded on videotape for later analysis and critique. Audiotape recording of the student's spoken language has been found widely useful in studying foreign languages.

Scoring student work by machine [A(10)=1 or A(57)=1] can save instructor time, perform item analysis and other checks on the reliability of printed tests, supply statistical information on individual students and groups of students, and assist the instructor in diagnosing student progress. Small computers are sufficient for these purposes. There are also relatively inexpensive mark-sense systems that can at least add up right and wrong answers.

If A(22)=0 or A(56)=0, an instructor can discuss the subject with several groups of students via a communication medium from a remote point. Students can discuss their problems among themselves and, upon coming to a difficult item, can query the instructor at a predesignated time. Closed-circuit TV or two-way radio have been used in this application.

SUMMARY

The foregoing discussion is summarized in Table 5, which notes the system elements that each strategy variable affects directly. Whatever affects student flow, of course, affects all other resources; these derived effects are not shown. Similarly, using a student leader as a presenter [__(6)=3] may release an instructor from classroom duties. Since this does not generate a positive requirement for an instructor, there is no check in the Personnel column.

Variables are listed in alphabetical and numerical order.

Table 5

EFFECTS OF STRATEGY VARIABLES ON SYSTEM DESIGN

Variable and Value	Meaning	Affects Student Flow	Generates Positive Requirements for Resources		
			Personnel	Materials, Programs	Equipment
A(1)=2 or A(1)=1 and __(54)≠0	Adapt teaching method to student learning capability.	x			
A(2)=1 or A(2)=2 and __(13)=1	Use variable pacing.	x			
__(6)=1	Presenter is: Instructor.		x		
=2	Any appropriate communication medium.	x		x	x
=3	Student leader.			x	
=4	Adaptive program.	x		x	x
=5	Fixed-duration program.	x		x	x
=7	Response-paced program.	x		x	x
__(7)=1	Stimuli for overt response integrated with scheduled basic instruction.			x	
__(8)=1	Responses permanently recorded.				x
A(10)=1	Classroom work with selected response machine scored.				x
=2	The instructor will score classroom work with selected response during his work day.		x		
__(14)=1	Pacer is: Student leader			x	
=2	Learner.			x	x
=3	Instructor.		x		
=4	Response-paced program			x	x
__(16)=1	Programmed guide supplied.			x	
A(17)=2	The student can discuss material presented by a communication medium with a monitor or instructor during the presentation.	x	x		
A(18)=1	The student can discuss material presented by a communication medium in a later session during regular class hours.	x	x		
=2	...outside of class hours.		x		
__(19)=1	An instructor will present follow-me demonstrations.		x		
=2	Any appropriate communication medium...	x		x	x
=3	A student leader...			x	
=5	A fixed-duration program...	x		x	x
__(21)≠0	Backgroumd materials and instructional aids will be supplied.			x	x
A(22)=0	During instruction by a communication medium, an instructor or monitor will be intermittently accessible to students via a communication medium.				x
__(23)	Denotes the amount of formal examination that will be by objective tests.			x	
A(28)=1	Students will receive free time as an incentive to reach course objectives.	x			
__(29)=1	The student will be provided with a model response after he has had time to respond.			x	
__(39)=1	Stimuli for overt response integrated with assignments for unscheduled study.			x	
__(45)=2	Assignments for unscheduled study will be presented by any appropriate communication med.			x	x
=4	...an adaptive program.			x	x
=5	...a fixed-duration program.			x	x
=7	...a response-paced program.			x	x
__(46)=1	Model responses will be provided in unscheduled study.			x	
__(47)=1	Learner responses in unscheduled study will be recorded.				x
__(48)=1	Learners will be able to go back over the material for unscheduled study.				x
__(50)=1	Models of student performance will be demonstrated by an instructor.		x		
=2	...any appropriate communication medium.	x		x	x
=3	...a student leader.			x	
=5	...a fixed-duration program.	x		x	x
A(51)=1	The instructor will have part of his work day for scoring examinations.		x		

Table 5--continued

Variable and Value	Meaning	Affects Student Flow	Generates Positive Requirements for Resources		
			Personnel	Materials, Programs	Equipment
__(52)=1	A guide and instructional aids for demonstrating models of performance will be provided.			x	
__(54)=1,2,3	Students will be divided into groups on the basis of their learning capability.	x	x	x	x
=4	Students will be treated on an individual basis.	x	x	x	x
__(55)=1	Reviews and examinations will be presented by printed materials.			x	
=0	...by the same means as the original instruction.		x	x	
A(56)=0	The instructor does not have to be physically present for discussion sessions.				x
A(57)=1	Objective tests will be machine scored.				x
A(58)=1	Students will score daily work in class.	x	x		
A(59)=1	The instructor will have part of his work day for scoring classroom work with constructed response.		x		
__(61)=1	A communication medium will be used in Type I instruction to make presentations requiring special facilities or equipment.	x		x	
=0	A communication medium will not be used...		x		
__(63)=1	An instructor will adapt teaching method to student learning capability.		x		
=2	An adaptive program...			x	x
=3	The learner...			x	x
=4	A student leader...[a]				
__(73)≠0	The average number of minutes spent in class checking or discussing an assignment for unscheduled study.	x	x		
A(76)=1	Students will be designated to take modified course content by prior information on their background.	x			
=2	...by evaluation of their work after an initial period.	x			
=3	...by a diagnostic pretest.	x		x	
A(77)≠0	Provides rules for scheduling discussion sessions.	x			
__(78)=1 or 2	An instructor or clerk must monitor instruction presented by a communication medium.		x		
__(80)≠0	Students in a variably paced course will be grouped by learning rate.	x	x	x	x
A(97)=1	Scheduled remedial sessions will be conducted by an instructor.		x		
=0	...in the same manner as basic instruction.	x	x	x	x
e(1,i)=1 or e(2,i)=1[b]	Denotes schedule of formal examinations.	x			
e(12,i)=1 or e(14,i)=1	Denotes schedule of reviews in regular class hours.	x			
e(15,i)=1 or e(17,i)=1	Denotes reviews (scheduled or unscheduled) for which special materials will be prepared.			x	x
e(21,1)=1	Special instructors will be provided for the slow track.		x		
e(21,2)=1	...for the fast track.		x		
e(25,1)=1	Students will be rewarded for achievement in a variably paced course.	x			
e(26,i)=1 or 2 or e(27,i)=1 or 2	Denotes examinations which will require an instructor or clerk as proctor.		x		

[a] No direct effects.

[b] Choice of variable depends upon the basis of examination schedule.

V. LOGICAL STRUCTURE OF DISTAF

This section describes parts of the DISTAF program whose logical structures are not immediately obvious. Strategy decisions fall into four major sections:

1. *General strategy.* Decisions that affect the course as a whole. They can be made without referring to details of instructional method or course content, and are a continuation of the policy decisions made in answering the Questionnaire for Stating General Policy described in Sec. II.
2. *Establishment of strategies for Type I instruction.* This section establishes values for each subcategory of Type I instruction for the six primary strategy variables discussed in Sec. III: presenter, background materials, integrated stimuli, recording responses, type of response, and feedback to learner. Values are also established for adapter or pacer, as applicable. Other decisions relevant to Type I instruction are made.
3. *Establishment of strategies for Type II instruction.* A similar, but more complex, process is followed for Type II instruction.
4. *Establishment of strategies for Type III instruction.* The program has not been completed for Type III instruction. Its general features are sketched here.

After the planner makes all decisions called for, the computer types out a text summarizing the strategies he selected. An example is shown in Appendix C.

The order used in this section in describing program flow generally goes from the most specific (least encompassing) to the most general (most encompassing), so that the program's more complex features can be built up. We first describe the decision logic for determining the values of the six primary strategy variables for scheduled Type I instruction. These variables form the core around which DISTAF is built. Their values are set for almost all categories of instruction; many of the more general decisions are directed toward providing a framework within which these values are set.

After discussing how values of other variables relating to scheduled Type I instruction are determined, we discuss the decision logic for all Type I instruction. The discussion of Type II instruction parallels that of Type I, but largely concerns

those points wherein the two decision flows differ; similarly, for Type III instruction. Finally, the general strategy of the first section is treated.

STRATEGIES FOR SCHEDULED TYPE I INSTRUCTION

Presentation

For Type I instruction, the computer directs the planner to choose the presenter which can be an instructor, student leader, any appropriate communication medium, fixed-duration program, response-paced program, or adaptive program. If the planner chooses an instructor for this role, he is next asked to decide whether he wants to supply the instructor with background materials, i.e., references, lesson guides, and instructional aids from which the instructor may draw his presentation. If the planner chooses not to supply such materials he next is asked to determine whether to use the appropriate communication medium to make presentations requiring special equipment or a special facility. Then this phase of the decision process is over.

If the planner chooses to supply background materials, however, the decision process continues, as illustrated on the flow chart of Fig. 4a at (6),[18] (9), and (12)-(14). The planner is next asked to decide whether to integrate stimuli for overt student response with the presentation (integrated stimuli) (6). If not, the decision on presentations with special requirements (13) is made next, as before. If stimuli are integrated, however, the planner is directed to designate what type of response should be elicited (selected or constructed) (9), to determine whether to give examples of acceptable answers to the learner after he has had a chance to respond (feedback to the learner) (9), and to determine whether to record the learner's responses (recording responses) (12). Again, presentations with special requirements must be considered [(13) and (14)] before this phase of the decision process is complete.

If the planner chooses a student leader as the presenter (4), the decision process is essentially the same except that the computer automatically decides that background materials will be supplied, as indicated by the upper rectangle surrounded by the double line in the center (5) of Fig. 4a.

If the planner chooses any appropriate communication medium or a fixed-duration program as the presenter (7), a communication medium carries the burden of instruction, making the decision on background materials irrelevant and therefore the computer skips it. Additionally, presentations with special requirements are automatically made by a communication medium or fixed-duration program, whichever is chosen for presentation (8). The remainder of the decision process is the same as before.

If the planner chooses either a response-paced program or an adaptive program as the presenter, the computer sets four variables automatically, as indicated by (11):

[18] Figures in parentheses refer to steps in the flow chart.

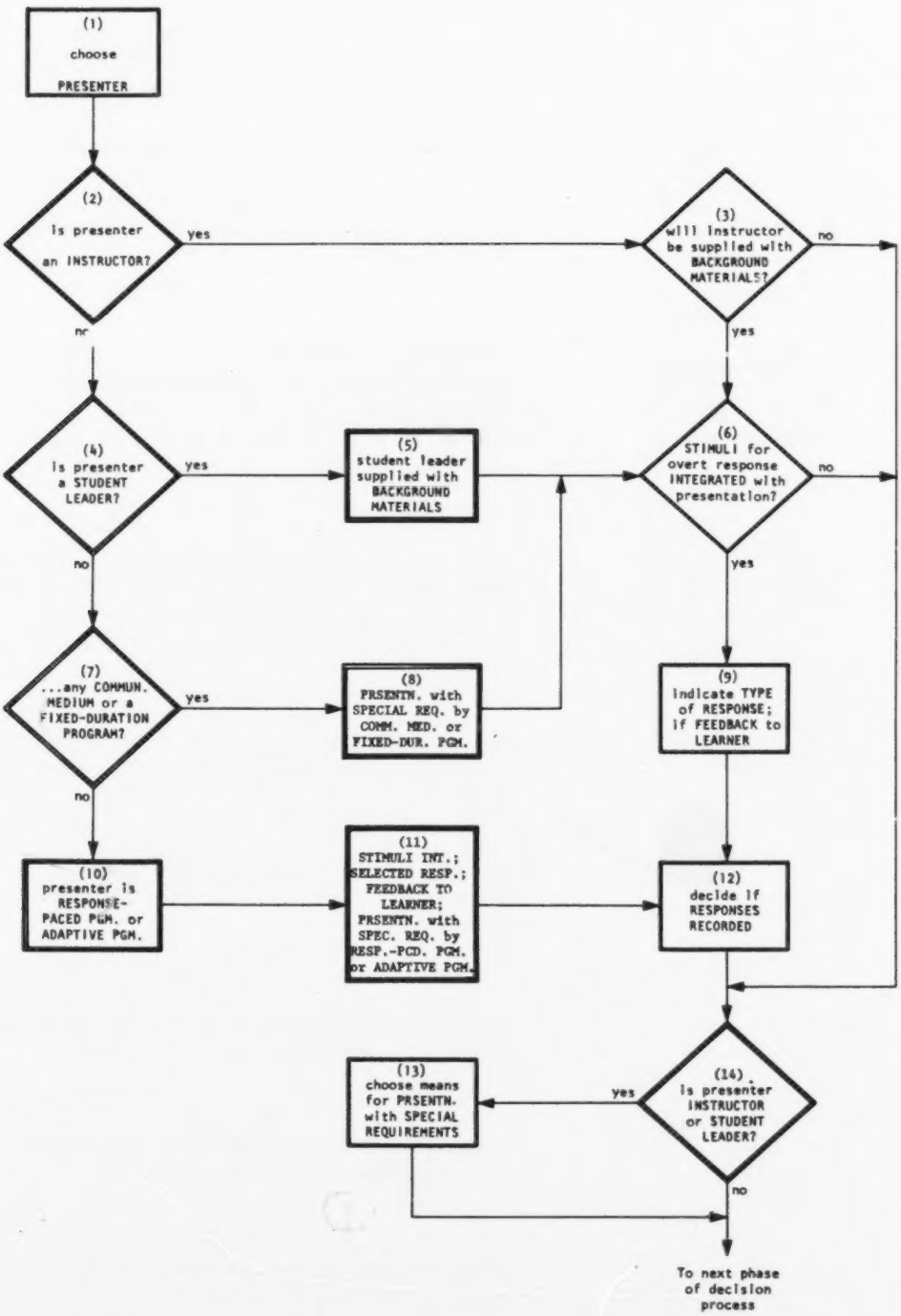
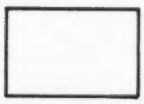


Fig. 4a—Decision sequence for presentation

DESCRIPTION OF SYMBOLS USED



Rectangle—a process that the planner carries out while seated at the console and interacting with the computer, e.g., *choose presenter,* (1) on Fig. 4a. The process is described briefly within the rectangle.

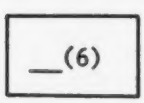
Rectangle with double line—the computer program automatically establishes strategy on the basis of the designer's decisions, e.g., *student leader willbe supplied with background materials,* (5) on Fig. 4a.

Diamond—a decision that the *planner* makes that causes the program to take alternative routes, e.g., (3) on Fig. 4a.

Diamond with double line—a point at which the *computer program* chooses alternate routes according to prior decisions, e.g., (2) on Fig. 4a.

Dashed symbol—a repeat of a symbol on a preceding figure as an aid to orienting the reader.

Arrow—program flow, which in general is downward and to the right.



Variables within rectangles or diamonds—their values are set at that point.

Numbers adjacent to symbols—refer to statements in the manual that accompanies the program. These statements present considerations that will assist the designer in making the decisions called for.

stimuli for overt response must be integrated with the presentation; selected responses must be called for; the learner must receive acceptable responses; a response-paced program or an adaptive program must make presentations with special requirements. After the planner determines whether to record responses, this phase of the decision process is over.

For readers who wish to follow the program in greater detail, Fig. 4a is reproduced in Fig. 4b, in which the names of the strategy variables replace the statements in the rectangles and diamonds, and the related statements in the User's Manual (Appendix B) are shown alongside the rectangles and diamonds.

Variable Pacing

If the planner chooses variable pacing to adapt scheduled instruction to student learning rate, he first is asked to choose the pacer: instructor, response-paced program, student leader, or learner. Each choice automatically determines a presenter, as shown in (4), (7), (10), and (13) in Fig. 5a.

If the pacer is an instructor (3), the planner is asked to decide whether to group students by learning rate (2) and, if so, to choose the number of levels of learning rate that he wishes to accommodate (5). Next, he determines whether the instructor will be provided with background materials that are programmed (11) and thus have integrated stimuli (14). Whatever his choices here, the computer next directs him to the decision process for setting values of presentation variables (symbolized by the dashed rectangle) just below the upper left rectangle of Fig. 4a; that is, just after the choice of presenter. The computer leads him through this process, skipping all decisions that have already been made. For example, the planner chooses to provide the instructor with programmed background materials, stimuli are integrated, and the computer skips that decision. It also skips the decision on background materials, since programmed background materials are, ipso facto, background materials.

If the pacer is a response-paced program (6), the presenter is a response-paced program, and the flow through the grouping decisions is the same as above. Thereafter, the process goes directly to Fig. 4a; the only decision not skipped on Fig. 4a is whether to record student responses.

If the pacer is a student leader (9), he must be supplied with programmed background materials (10). These include stimuli for overt student response so that the student will know how to pace the learner(s). Again, the grouping decisions are made and presentation variables are set; all variables whose values have been determined are skipped, as before.

If the pacer is the learner (12), whatever communication media are appropriate are programmed (13) with integrated stimuli, and must provide the learner with models of acceptable responses so that he knows how to pace himself. There can be no grouping by learning rate, of course.

Figure 5b relates the decision sequence for variable pacing to the program and manual.

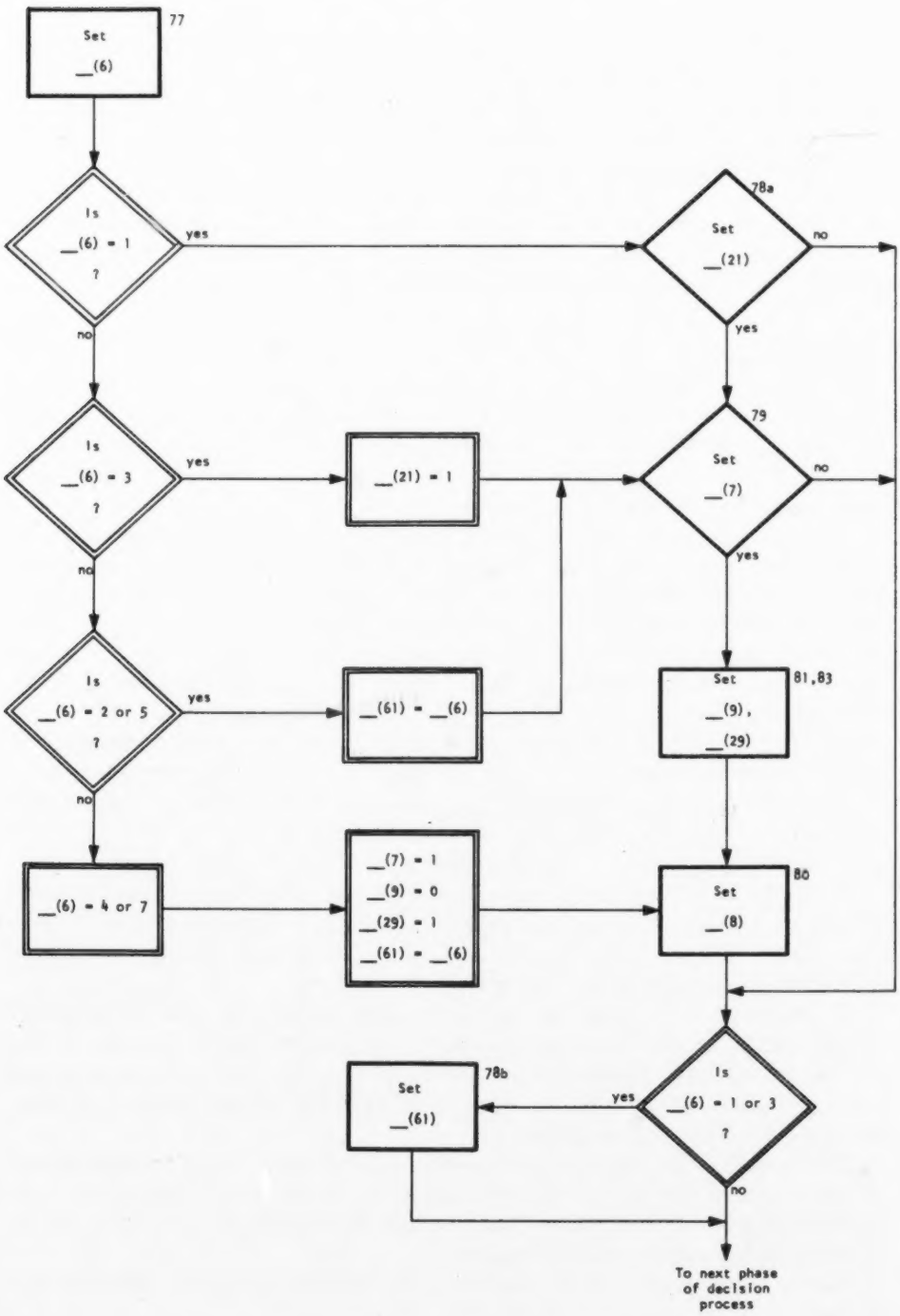


Fig. 4b—Program flow for setting presentation variables

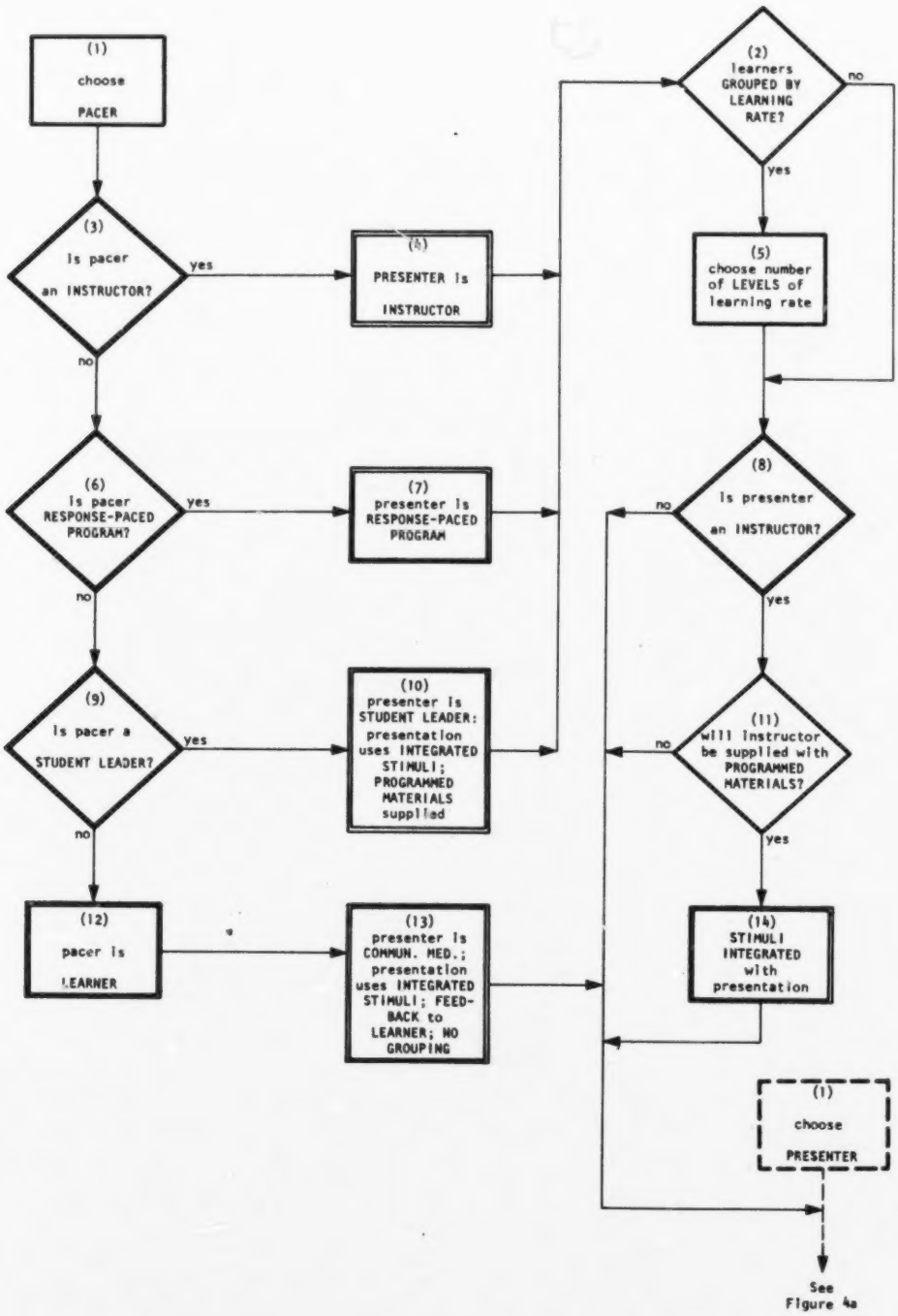


Fig. 5a—Decision sequence for variable pacing

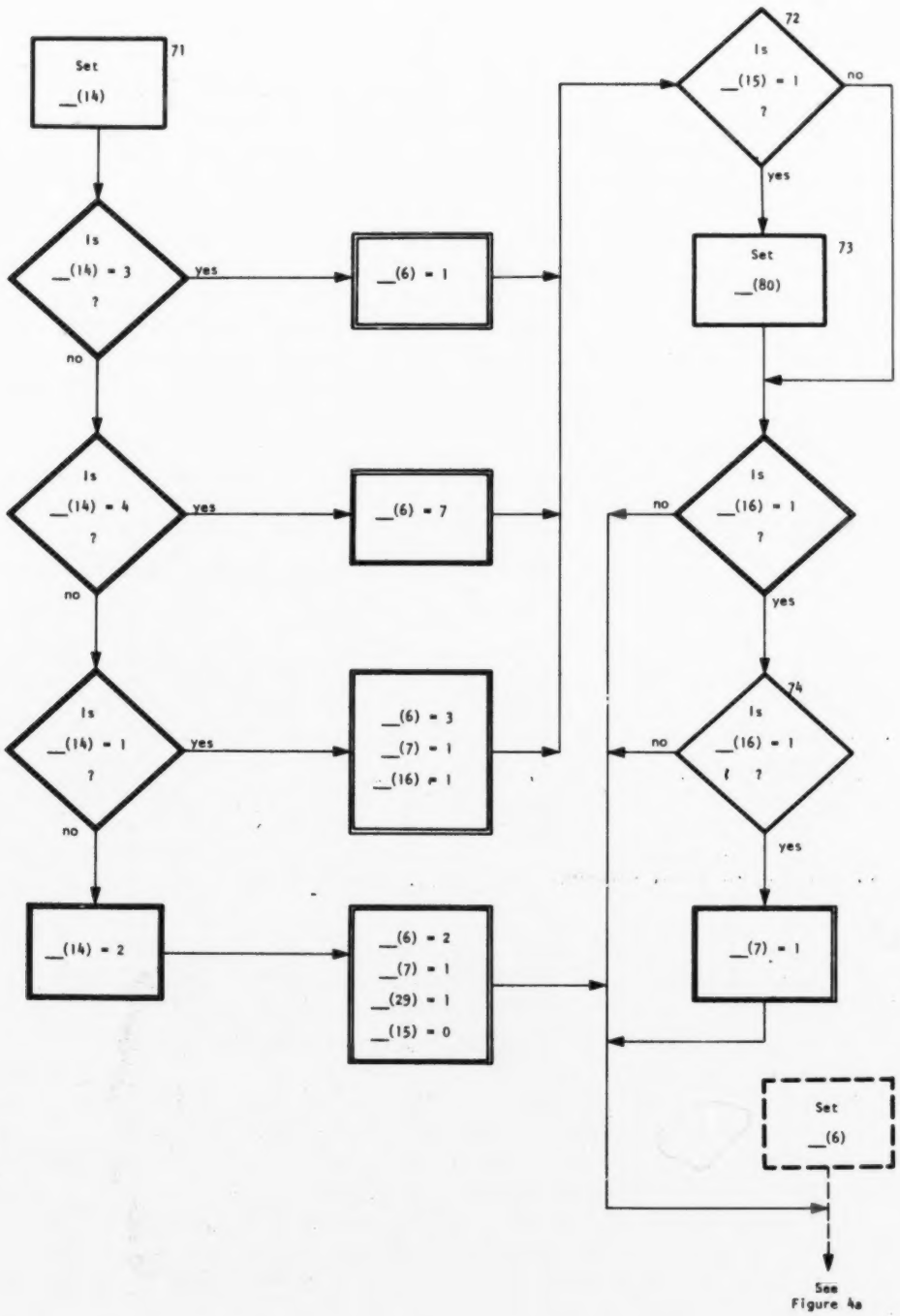


Fig. 5b—Program flow for setting variables for variable pacing

Adaptive Method, Step I

If the planner chooses to adapt the method of instruction to student capabilities in a more general way than by variable pacing alone, he must choose the adapter, whose role can be similar to that of the pacer. Choices for adapter are instructor, student leader, learner, and adaptive program, as shown in Fig. 6a. Unless the adapter is the instructor, the computer automatically determines the presenter, and sets some other values (6), (9), and (13). If the adapter is an instructor, a student leader, or the learner, the planner next is asked to decide whether any **stratified materials** (materials prepared on several levels of difficulty (2)) will be used. If the adapter is an instructor (4), the presenter is chosen next (7), as the instructor may perform between-session adaptivity, and concurrent adaptivity may be performed by some other means. The choices for presenter in this case are the same as those in Fig. 4a. If the presenter chosen is either an instructor or student leader (10), the planner decides whether to provide programmed (branching) background materials (11) before entering the decision sequence in Fig. 4a. As before, the computer automatically skips decisions relating to variables whose values have already been determined.

Figure 6b relates the decision sequence for adaptive method to the program and the manual, as shown.

Adaptive Method, Step II

Actually, the decision sequence for the adaptive method is somewhat more general than that for variable pacing because decisions on grouping must precede the choice of adapter. This set of decisions is shown in Fig. 7a, which is largely self-explanatory. Step (7), however, introduces a concept of program flow not discussed previously—the return or loop, in which the computer has the planner repeat the same process for each track or group until he has determined strategy for each one.

It is implicit that if students are put into tracks, instructional method must be adapted to student learning capabilities for the entire course because each track is in essence a separate course. Alternatively, ability groups may be formed within classes or other aggregations of students. One choice is to treat each learner as an individual, that is, to form no ability groups. Whichever strategy is chosen, the adapter must be designated for each track or group for all individuals.

As Fig. 7b shows, the decision sequence for Fig. 7a is related to both the DISTAF program and to the Questionnaire for Stating General Policy because the decision on tracking is made at the highest level of generality.

The variable A(60), shown in the lower left diamond, is a flag whose value is automatically assigned by the computer. It keeps account of the group or track for which strategy is being designed. When its value reaches 3, strategy has been set for all groups or tracks.

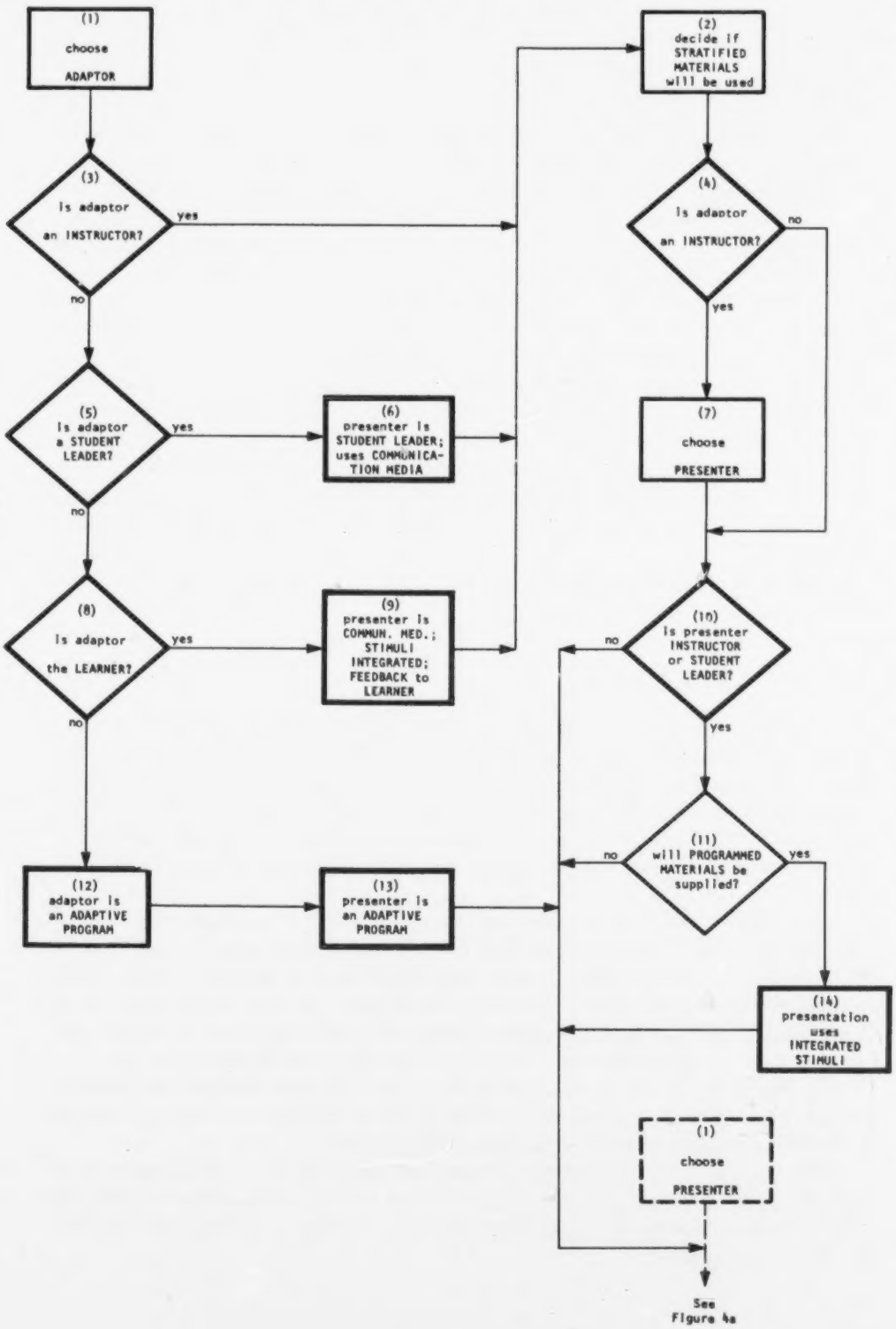


Fig. 6a—Decision sequence for adaptive method, step 1

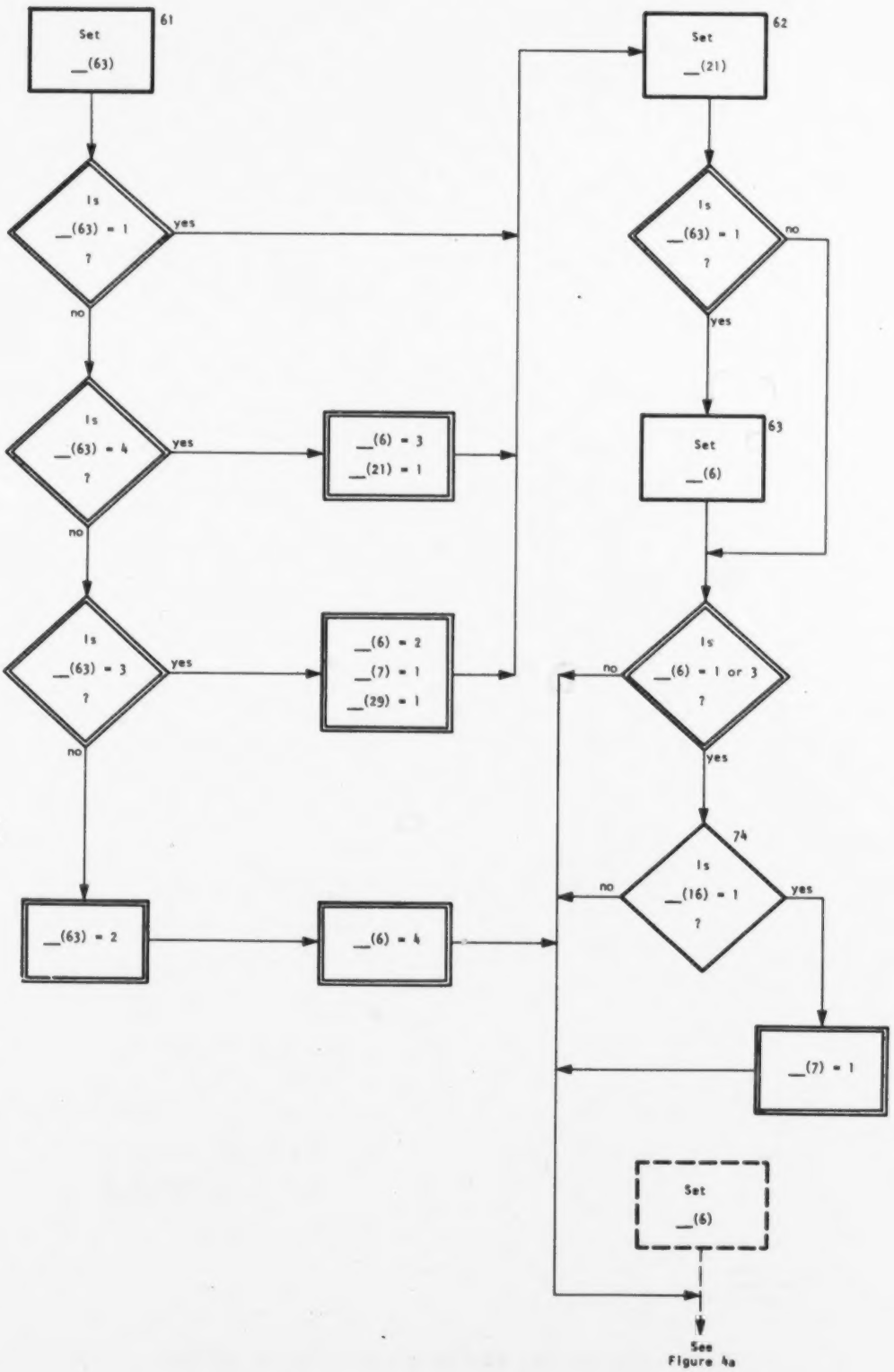


Fig. 6b—Program flow for setting adaptivity variables (step 1)

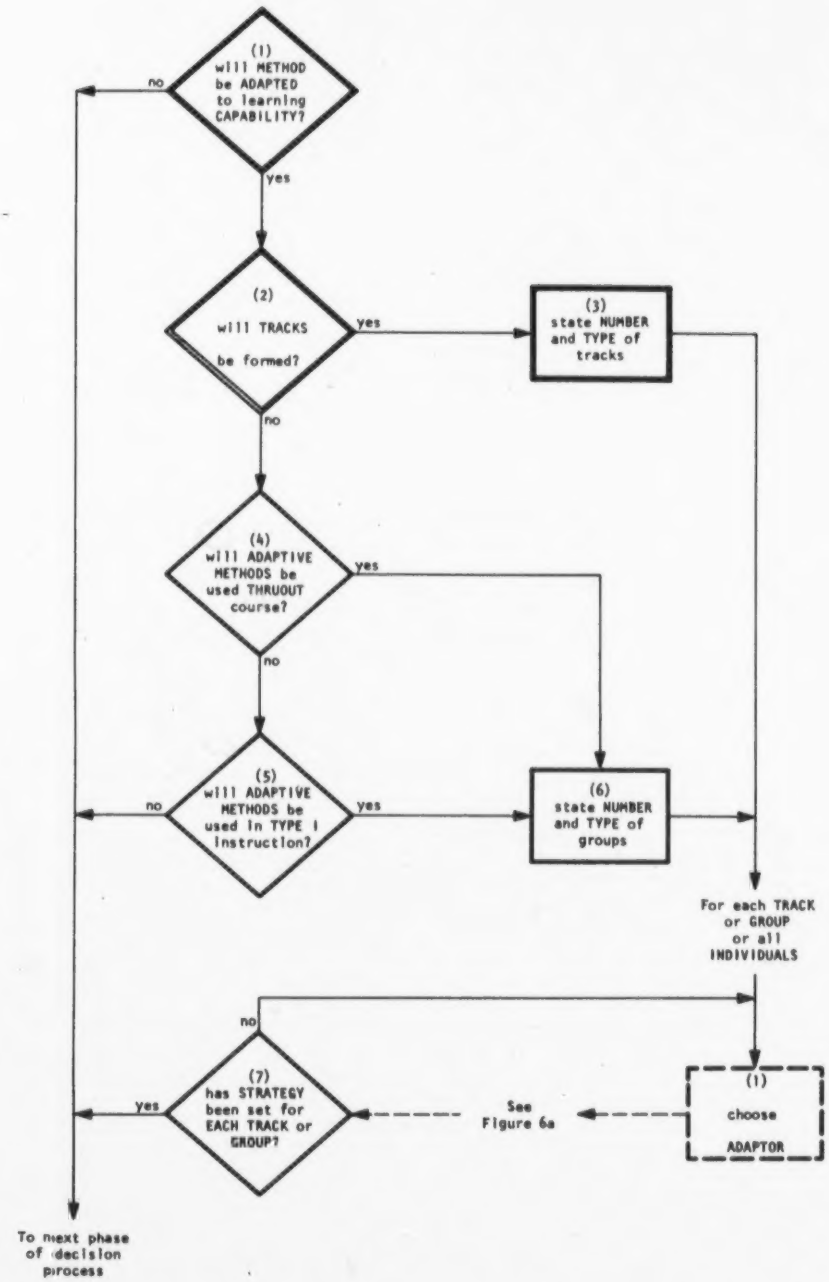


Fig. 7a—Decision sequence for adaptive method, step 2

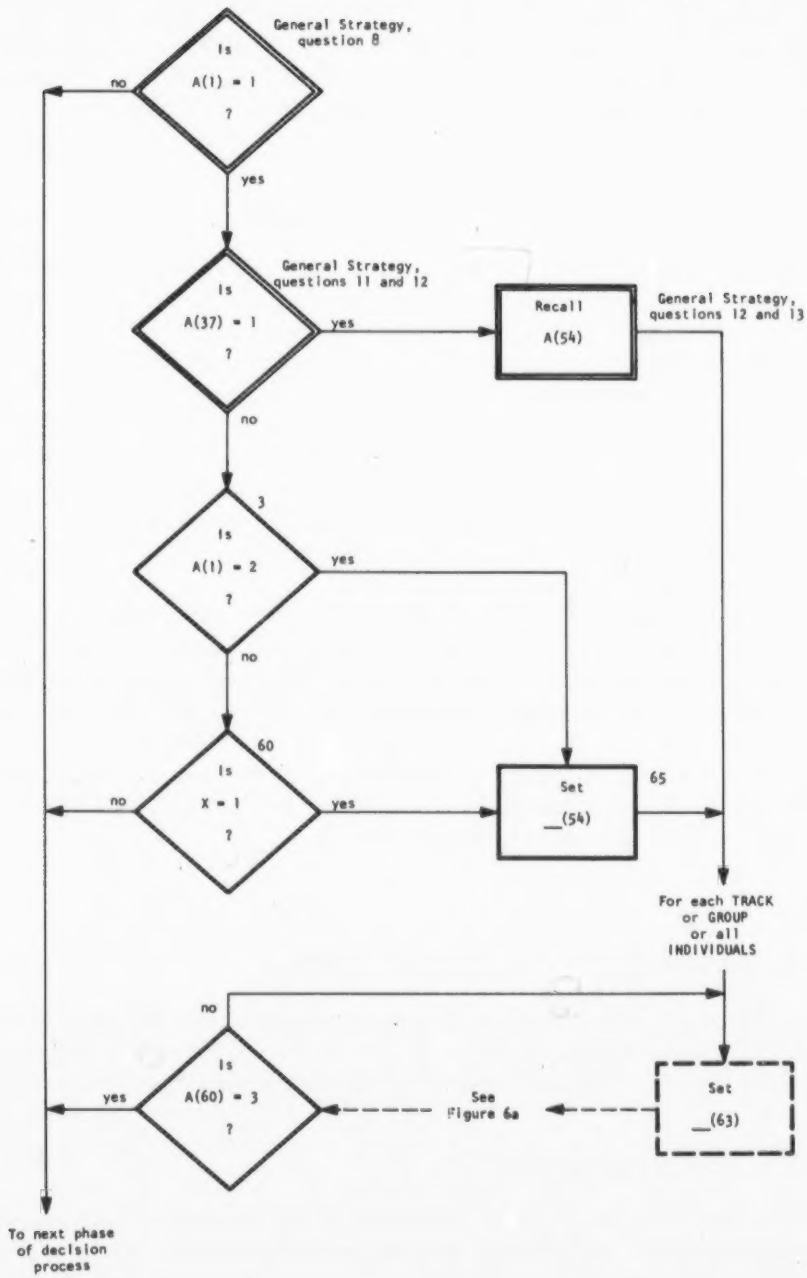


Fig. 7b—Program flow for setting adaptivity variables (step 2)

Fixed Schedule

If students must master course content on a fixed schedule, the planner is not allowed to choose either a student leader or the learner himself as either an adapter or pacer of scheduled instruction. This is so that the schedule may be maintained. Because this limitation must be imposed at so many points in the program it is not shown explicitly on any of the flow charts.

Decision Sequence for Scheduled Type I Instruction

The decisions on adaptivity, variable pacing, and presentation just discussed follow each other as shown in Fig. 8a. This flow is a loop through which the planner passes twice, if necessary. First he decides whether he wants to consider two levels of subject matter difficulty (1). This gives him the chance to establish two separate strategies for Type I instruction, if he so desires. The program then has him enter a loop for establishing strategy for each level, beginning with the simplest. The program flow is identical for each level, but the manual provides the planner with different pros and cons to consider for each level. After strategy is determined for the lowest level of difficulty, the program switches the planner back to the beginning of the loop if there is a higher level of difficulty to be considered (3). If not, this phase of the decision process is complete.

Note that decisions on variable pacing (2) are made only if more generally adaptive methods are not used, although variable pacing is a consequence of most of the decisions possible under adaptive method. The computer goes directly to decisions concerning presentation if neither adaptive method nor variable pacing is used.

As in Fig. 7b, Fig. 8b contains a flag-variable [A(5)] whose value is automatically set by the computer. When decisions are being made concerning instruction on simple topics, A(5)=0; if they are difficult, A(5)=1.

STRATEGIES FOR ALL TYPE I INSTRUCTION

Figures 9a and 9b show the overall flow for setting strategies for Type I instruction. We have discussed all parts of this flow except its beginning and ending, i.e., the establishment of examination and review strategy (1) and the wrap-up (2).

Wrap-Up of Type I Instruction

Because the flow through the wrap-up depends on decisions concerning scheduled instruction, which we have just discussed, we treat the wrap-up first. This is shown in Fig. 10a. It includes two strategies: (1) scoring classwork and scheduling discussion sessions, which depend on the preceding strategy; and (2) selecting the type of tests for formal examinations and establishing a strategy for unscheduled

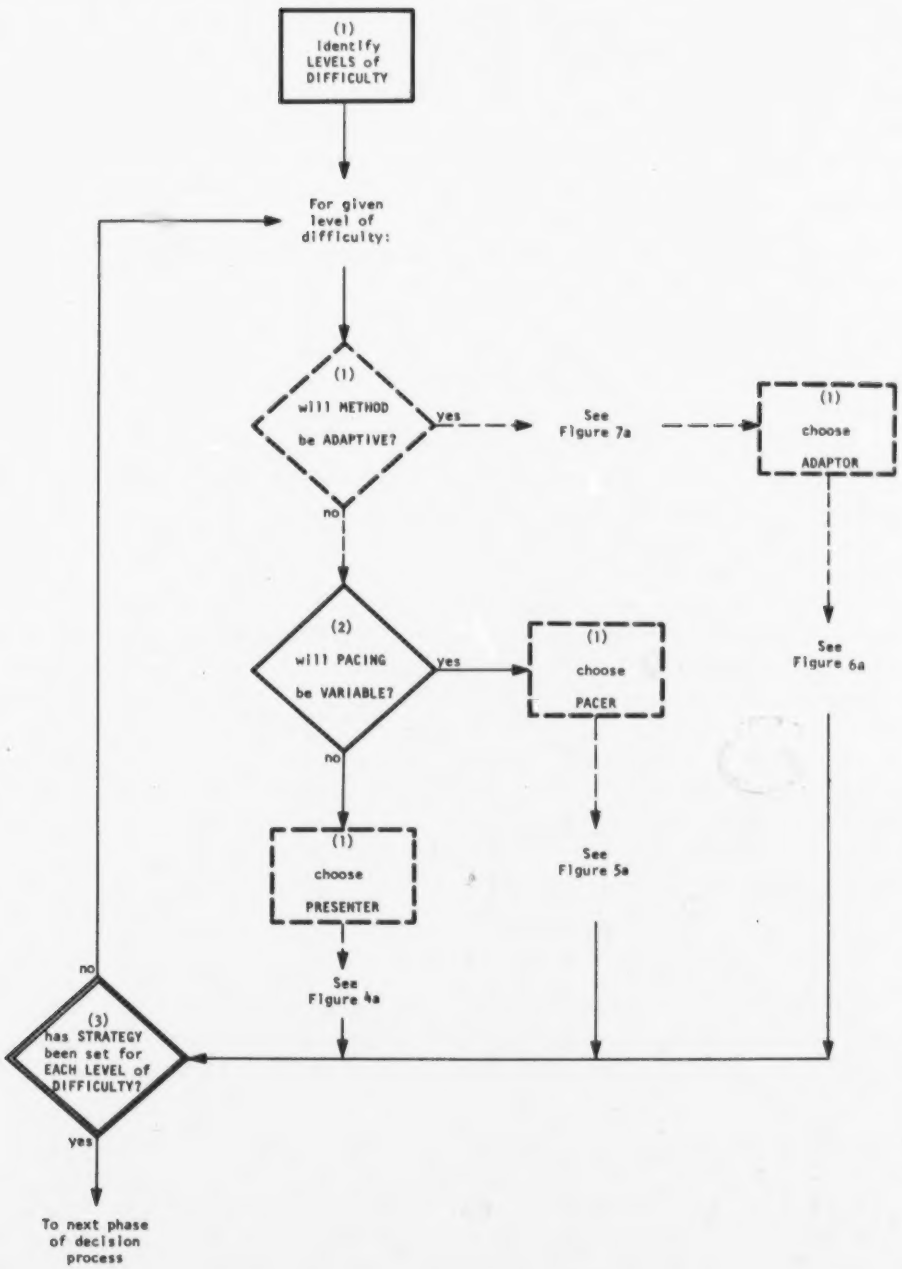


Fig. 8a—Decision sequence for scheduled Type I instruction

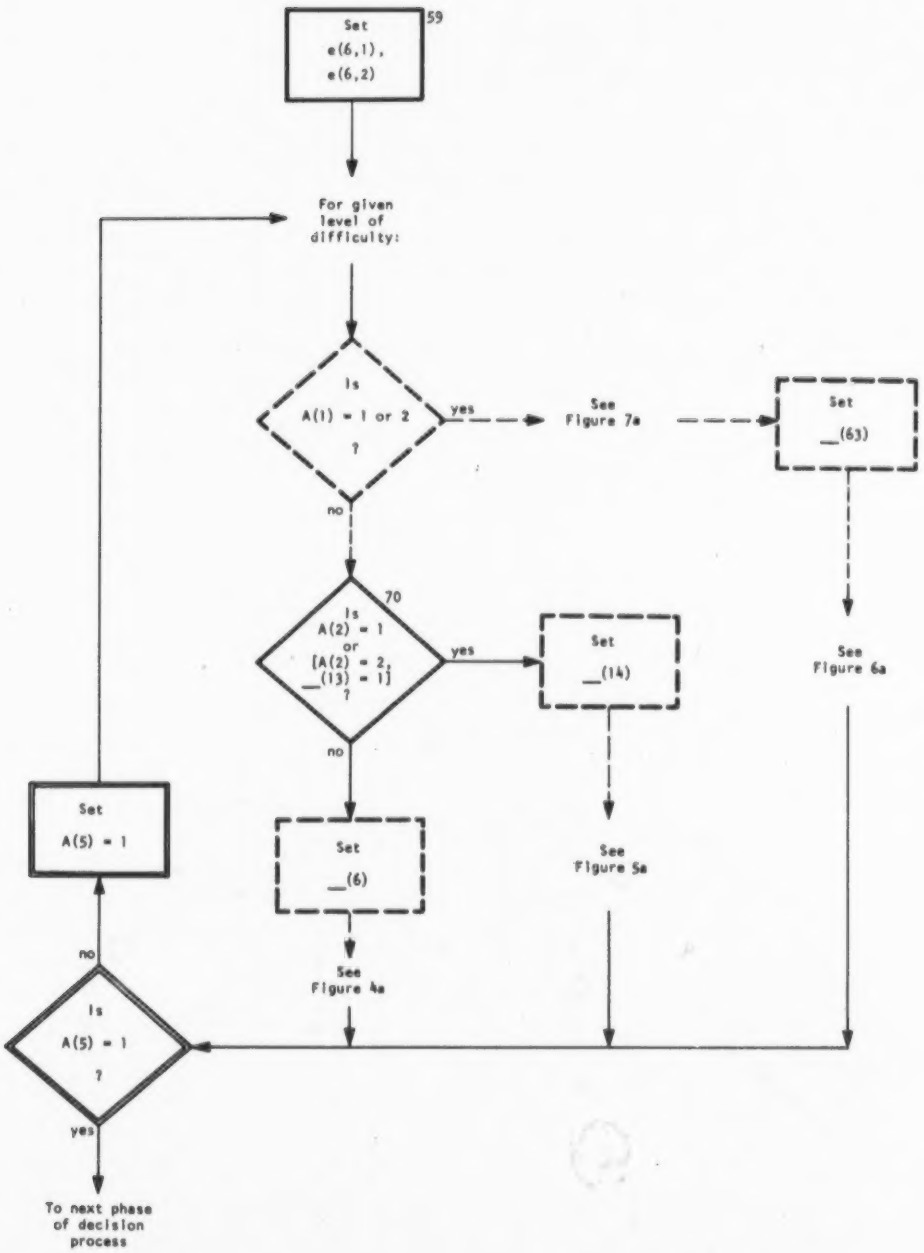


Fig. 8b—Program flow for setting variables for scheduled Type I instruction

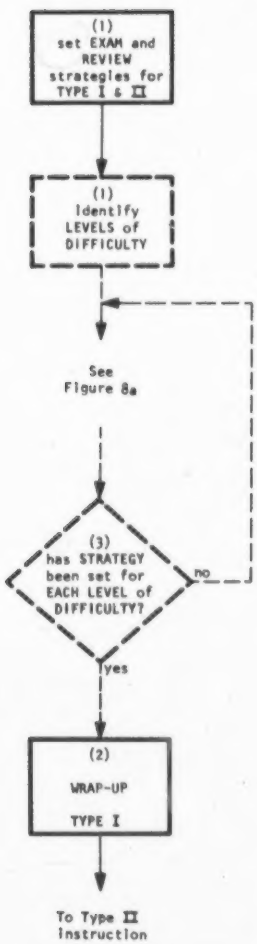


Fig. 9a—Decision sequence for all of Type I instruction

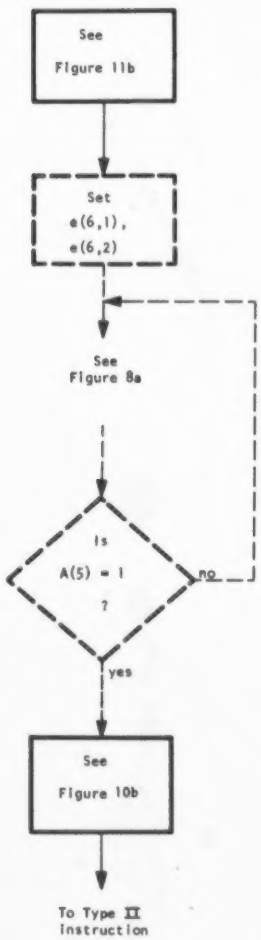


Fig. 9b—Program flow for setting variables for all of Type I instruction

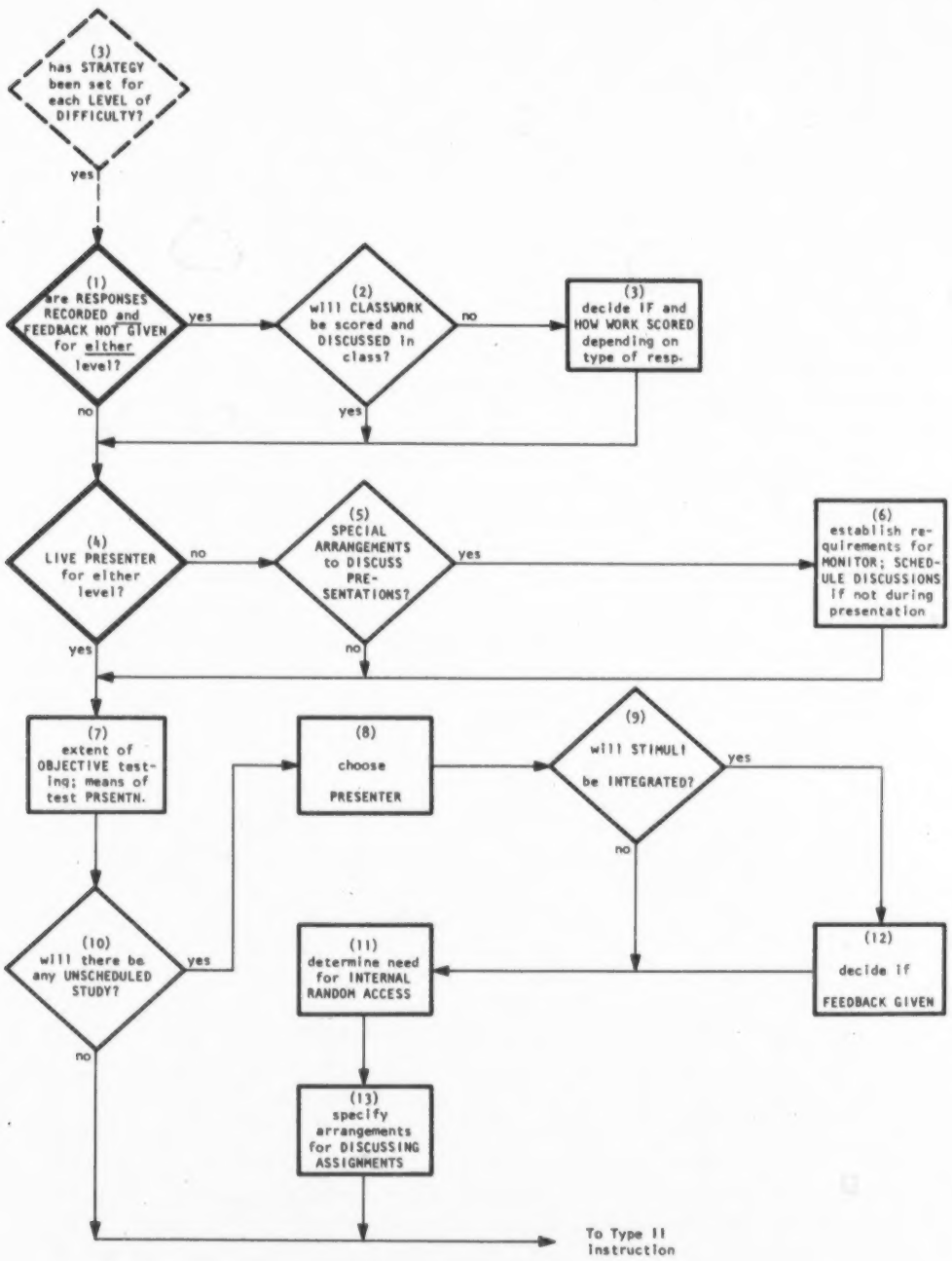

(3) has STRATEGY been set for each LEVEL of DIFFICULTY?
yes
(1) are RESPONSES RECORDED and FEEDBACK NOT GIVEN for either level?
yes
(2) will CLASSWORK be scored and DISCUSSED in class?
no
(3) decide IF and HOW WORK SCORED depending on type of resp.
no
yes
(4) LIVE PRESENTER for either level?
no
(5) SPECIAL ARRANGEMENTS to DISCUSS PRE-SENTATIONS?
yes
(6) establish requirements for MONITOR; SCHEDULE DISCUSSIONS if not during presentation
yes
no
(7) extent of OBJECTIVE testing; means of test PRSENTN.
(8) choose PRESENTER
(9) will STIMULI be INTEGRATED?
yes
no
(10) will there be any UNSCHEDULED STUDY?
yes
no
(11) determine need for INTERNAL RANDOM ACCESS
(12) decide if FEEDBACK GIVEN
(13) specify arrangements for DISCUSSING ASSIGNMENTS
To Type II Instruction

Fig. 10a—Decision sequence for wrap-up of Type I instruction

study, which may be influenced by what the planner considered while setting the preceding strategy.

At a given level of difficulty student responses may be recorded and models of acceptable responses may not be immediately provided to the student. If this occurs for either level of difficulty (1), the planner may want to use the scoring of student classroom work (classwork) as an opportunity for additional instruction in class or as information on student progress. If student classroom work is not scored in class (2), the type of response elicited will determine the next decision to be made (3). If the responses are constructed, the instructor may score them during his work day, after school, or not at all. If the responses are selected, they may be machine scored or the instructor may score them, the latter task occupying only a brief time.

If at both levels of difficulty answers *are* provided to stimuli for overt student response, there is no need for special sessions to *score* student work because students can compare their answers with those provided as they go along. Therefore the computer will have the planner bypass this section.

Students may still need to discuss their work if they have been working independently of the instructor or the student leader. Therefore, if at either level of difficulty instruction is not presented live, the planner may want to schedule discussion sessions following the presentation to clarify points and to answer questions as necessary (5). (We assume that if an instructor or student leader makes the presentation, students will have an opportunity to discuss the material with him.) In addition, it may be desirable to review the presentation by discussing it in a class group, a standard procedure in many classrooms. If the planner decides to schedule separate discussion sessions, he is asked to estimate the time they will take as a percentage of basic presentation time and specify the ground rules for scheduling the sessions (6).

The planner next decides how much objective testing he wants to do. If he decides to use selected student responses in any portions of Type I instruction, he may quite naturally decide that formal examinations will be objective tests, i.e., call for selected responses (7). If some or all of Type I instruction calls for constructed responses, however (or for no overt response), he may be reluctant to use objective tests as formal examinations. Similarly, the means he chooses for presenting formal examinations (7) will be influenced by his choices of the means for basic instruction. In this program the means for presenting review materials is assumed to be the same as that for presenting formal evaluations of the students' mastery of these materials.

The decisions on unscheduled study (8)-(13) permit the design of instruction to be almost as varied in this mode as do those for scheduled study. The limitations are that a live instructor or class monitor cannot present assignments, and that the student is assumed to be studying as an individual. Decisions on unscheduled study may depend on strategy for scheduled study. For example, if the planner has opted for individually response-paced programs for scheduled instruction, he may want to use the same equipment for unscheduled study. Because some choices for the presenter of unscheduled study assignments can lead to a fixed-duration program, the planner is specifically asked if he wants to be sure that the learner has internal

random access to the materials (11). Decisions on whether and how assignments for unscheduled study are checked and discussed (13) complete this phase of the decision process.

Figure 10b, which shows the program flow for Fig. 10a, requires some explanation. The set-direction for statement 38 (upper right rectangle) applies to variable A(10) if __(9)=0 or to A(59) if __(9)=1. For simplicity, this additional branch was not shown on Fig. 10a. Similarly, if A(17)=1, variables A(12), A(18), A(56), and A(77) are set (next line down), but if A(17)=2, variables A(20) and A(22) are set.

Examinations and Review

Returning to Fig. 9a, we see that the first decisions concerning Type I strategy involve examinations and review. The decision flow is shown on Fig. 11a. Since Types I and II are classroom instruction, student mastery of course content can be tested without the use of special facilities or equipment. Therefore, a single strategy for examinations and reviews can be applied reasonably to both types of instruction at once. Examination and review strategies for Type III instruction, however, must be established separately. Thus, the decision sequence on Fig. 11a establishes strategy for both Type I and Type II instruction.

If the planner wants course content mastered on a fixed schedule (1), the computer directs him to establish the basis for the examination schedule; that is, whether examination frequencies should be geared to course content or to the calendar (2). If the schedule is not fixed, the only reasonable basis is course content, as it may not be possible to predict where students will be in the course at a particular time.

Next, the planner designates the frequencies of examinations (3), establishing their average length in minutes, the extent of course content they will cover, and the level of proctor the examination requires (4). He then determines when examinations will be scored (during the working day or after it) and how (by instructor or machine, if selected responses are called for) (5).

The next set of strategies concerns review (6). Usually a course designer does not explicitly consider the way reviews are going to be conducted, but relies on the instructor to provide reviews as they are needed. For system design, the time and means for review must be explicitly considered. The planner first determines whether or not to schedule reviews before all examinations (7). If not, he designates what type of examinations (daily quiz, final examination, etc.) to precede by reviews (8) and the review strategy for each type—that is, whether the review is conducted during scheduled instructional hours (9) or unscheduled study, whether materials are provided especially for the review (11), and an estimate of the average time required, if the review is carried out during scheduled study (10).

The program flow on Fig. 11b is highly condensed. A(4) established the basis for the examination schedule. If A(4)=1, the set of double-subscripted e-variables for which i=1 to 3 is involved in the decision process (upper or left sides of dashed lines). If A(4)=0, the other set of e-variables is used. The statement "For each i=1 to 3,

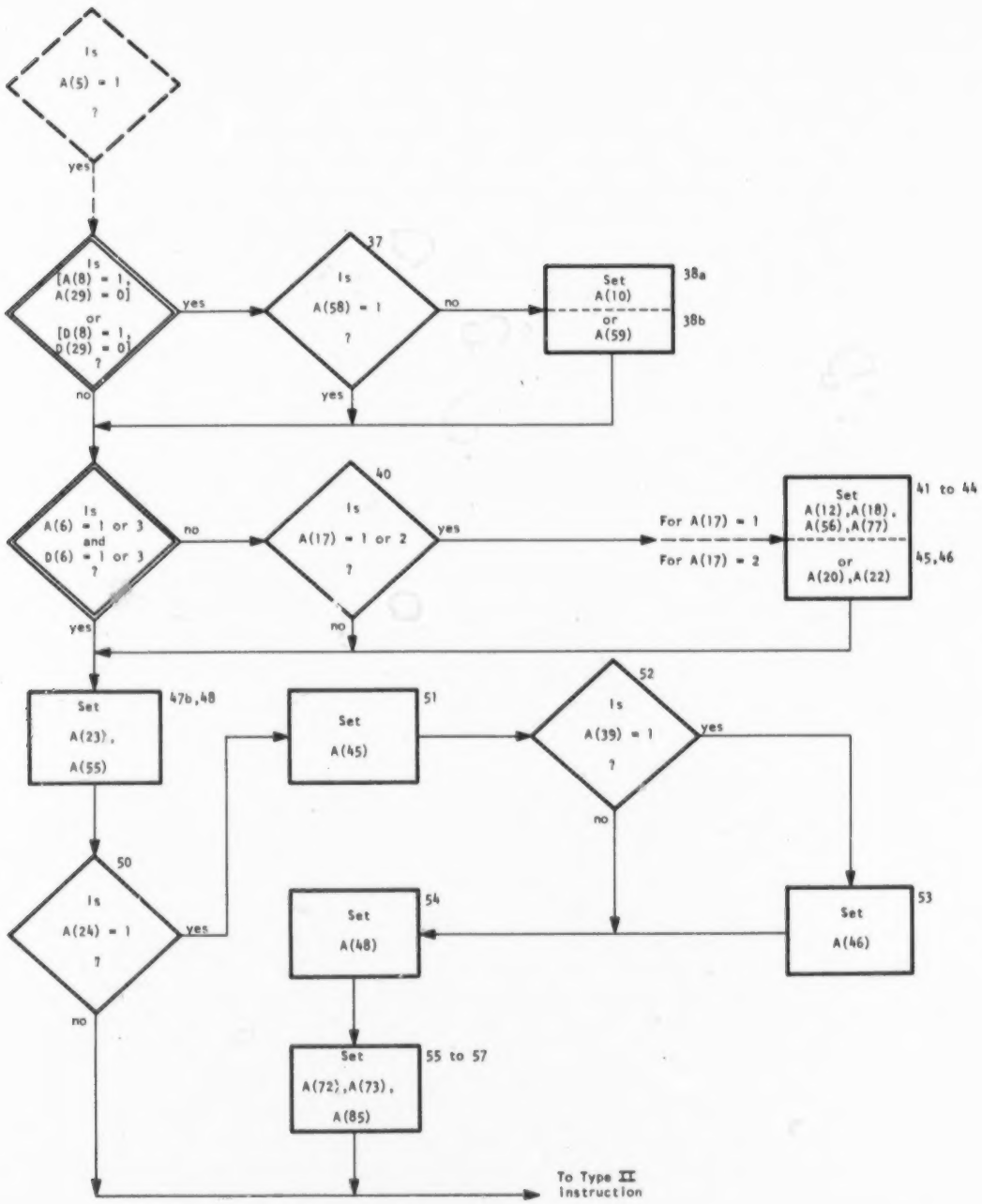


Fig. 10b—Program flow for setting variables to wrap-up Type I instruction

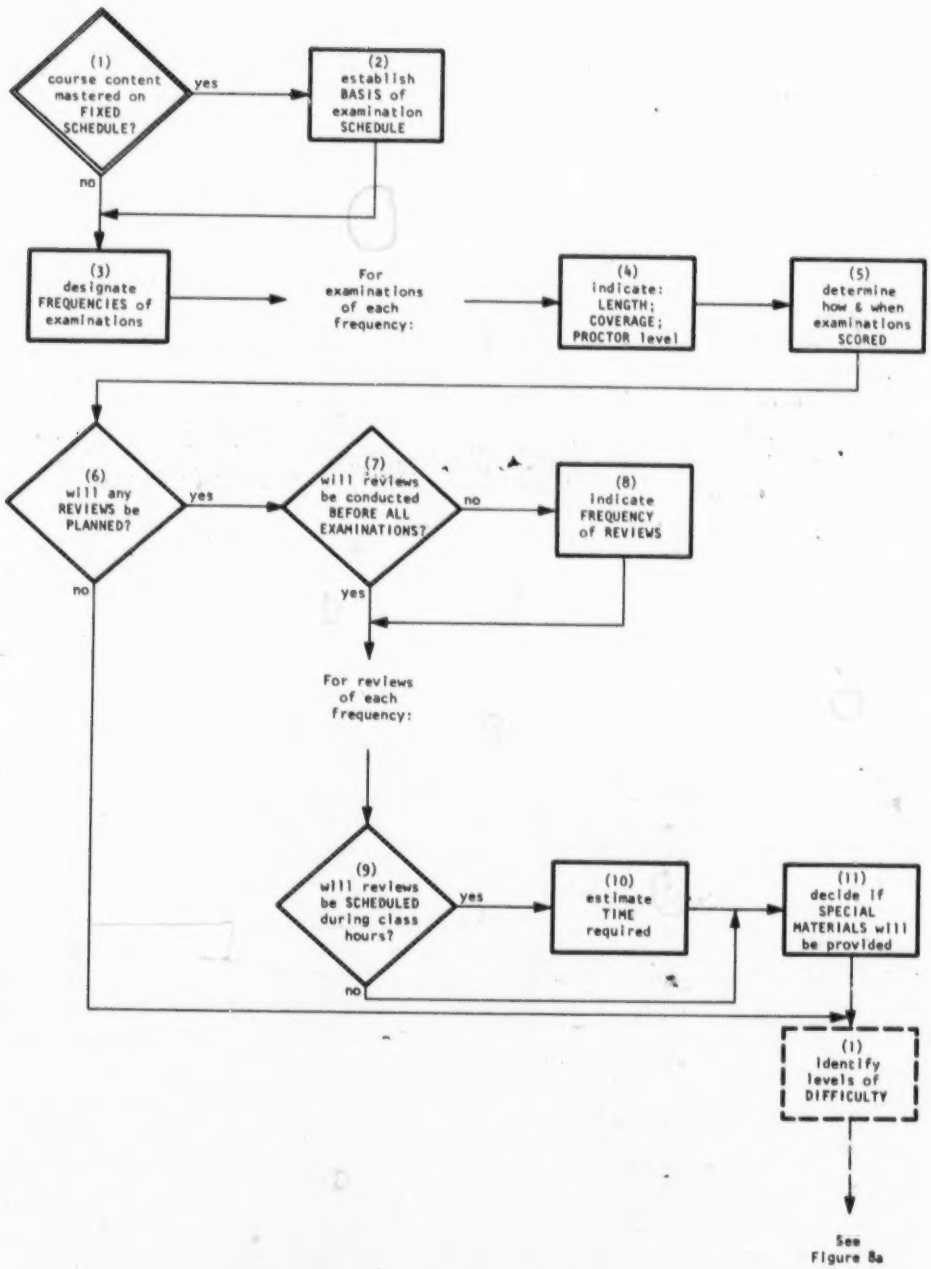


Fig. 11a—Decision sequence for examinations and review (Types I and II instruction)

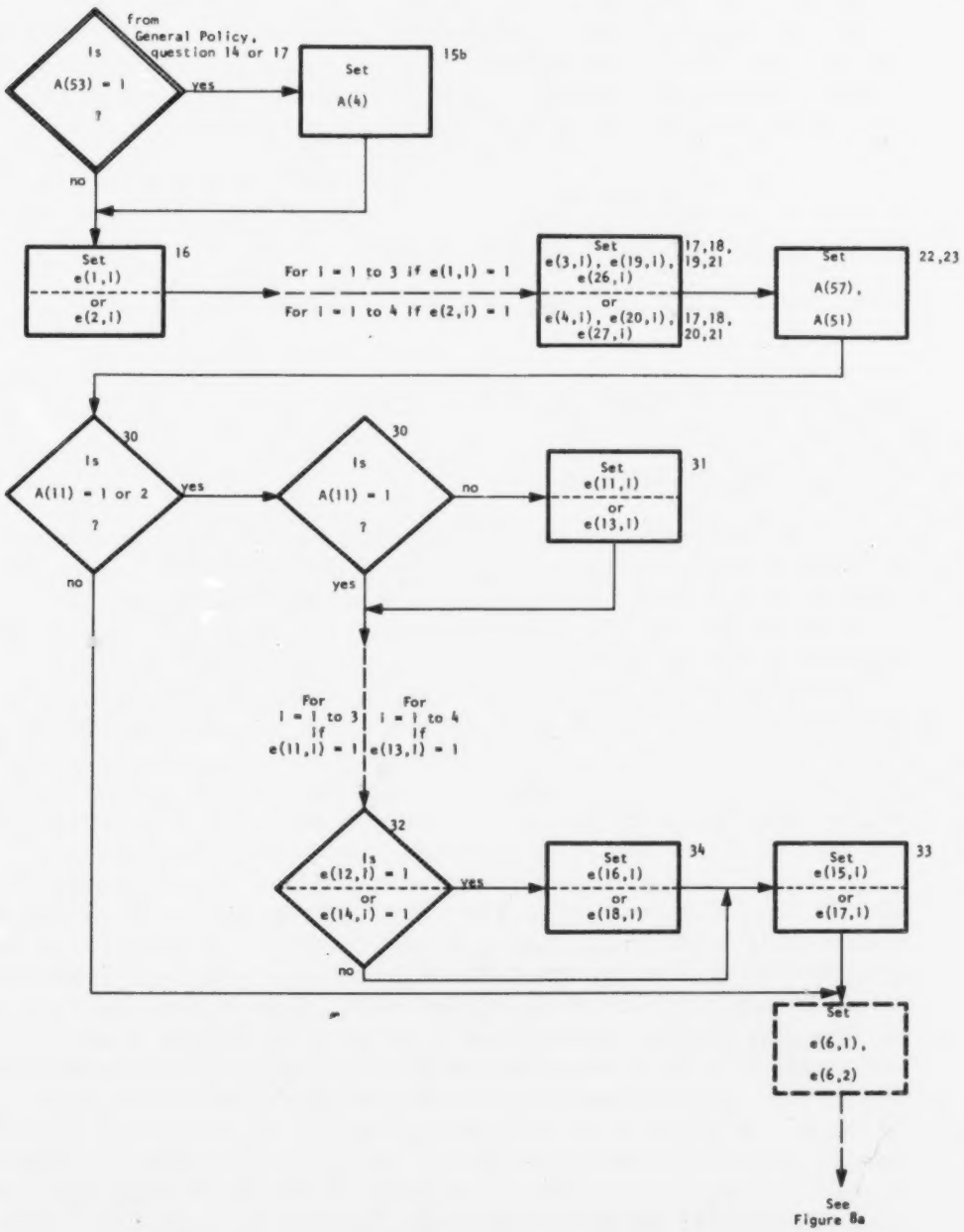


Fig. 11b—Program flow for setting variables for examinations and review (Types I and II instruction)

if e(1,i)=1" means that the subsequent decisions are made for each set of examinations administered at a given frequency [e(1,i)=1]. If examinations are *not* administered [say e(1,1)=1] at a given frequency, the computer goes to the next value of i.

Setting the review strategy involves a similar process. If A(11)=1, the computer sets e(11,i) [or e(13,i)]=1 for each i for which e(1,i) [or e(2,i)]=1. If A(11)=2, the planner is asked to set these values himself. Then the subsequent decisions are made for each set of reviews planned at a given frequency [e(11,i)=1].

STRATEGIES FOR TYPE II INSTRUCTION

As before, we first discuss how strategies are established for scheduled instruction, working from the more specific to the more general. Then we trace the flows for establishing strategies for unscheduled study, discussions of scheduled instruction, formal examinations, and review.

Scheduled Type II Instruction

Because in Type II instruction students are learning skills, their overt responses are actually the subject matter of what is being taught. Hence, the computer designates that Type II instruction integrate stimuli with the presentation, as shown in (1) on Fig. 12a. To provide the necessary routing for later decisions, the planner first decides whether to use follow-me demonstrations in teaching the skills (2).

Since student response is the key to Type II instruction, the *type of response* that is being sought is of primary importance. Almost without exception, the skills taught require constructed student responses. Even so, there may be instances when student mastery can be checked and diagnosed by selected responses. Arithmetic is an obvious example. Since the planner may want to set strategy for both contingencies (3), he passes through the same basic sequence for both [(4)-(7) and (8)-(11)].

If constructed responses are needed (4), the planner designates values for strategy variables having to do with presenting directions and stimuli for student performance (5). The decision sequence encapsulated in (5) is similar to that shown on Figs. 4a, 5a, or 6a, as appropriate. The major difference is that since stimuli are integrated (1) and constructed responses are needed (4), the computer has the planner skip these decisions [(5) and part of (7) on Fig. 4a]. In addition, since students are learning skills that do not require special facilities or equipment, presentations of those skills do not have special requirements. Hence, the computer also skips (11) on Fig. 4a. The planner is therefore left with choosing the presenter (or pacer of adapter, as applicable), making decisions on the types of background materials to be used if the presenter is an instructor or student leader, and deciding whether or not to give feedback to the learner and whether or not his responses will be recorded.

Returning to Fig. 12a, the computer checks whether the planner wants to use follow-me demonstrations (6); if so, the planner next chooses the leader for these (7).

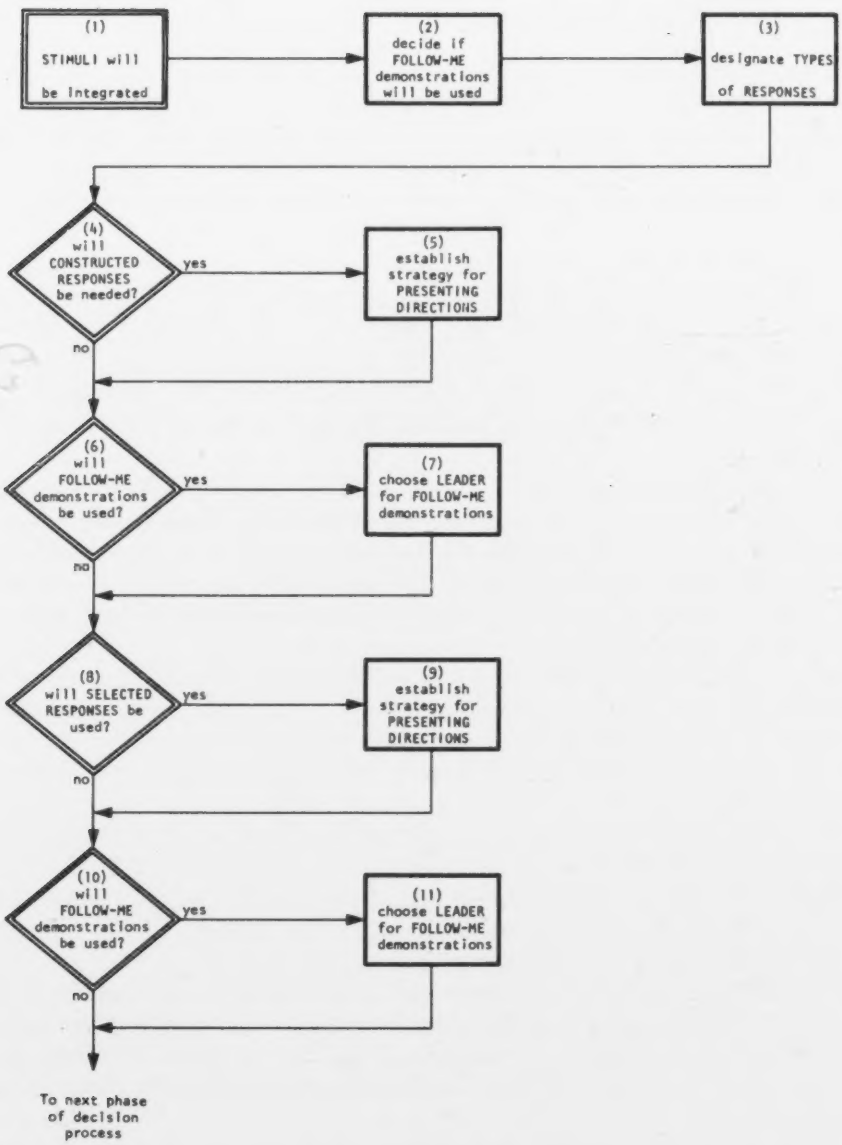


Fig. 12a—Decision sequence for scheduled Type II instruction

He then goes through the same sequence if selected responses are used (8)-(11). Although the flow is the same for both constructed and selected responses, the choices for presenter (or pacer or adapter) are different. This is because response-paced or adaptive programs can be used only if selected responses are called for.

Figure 12b is self-explanatory.

Type II Instruction, Individual Skills

The decision flow of Fig. 12a is embedded in Fig. 13a, which shows the decision flow for all of Type II instruction that teaches individual skills. Although most classroom teaching is aimed at developing individual skills, some classroom skills require teamwork or other group interaction. Participating in group discussion, reading a part in a play, or playing a game that does not require special facilities or equipment are all interactive skills in Type II instruction. It is important to separate them from individual skills because communication media are much less useful for interactive performance. Hence, Fig. 13a begins by asking the planner whether any individual skills will be taught (1). If so, the computer checks to see whether examination and review strategies are already established (2). As mentioned, this will be the case if Type I instruction is included in the course. If not, examination and review strategies are established (3) using the decision sequence of Fig. 11a.

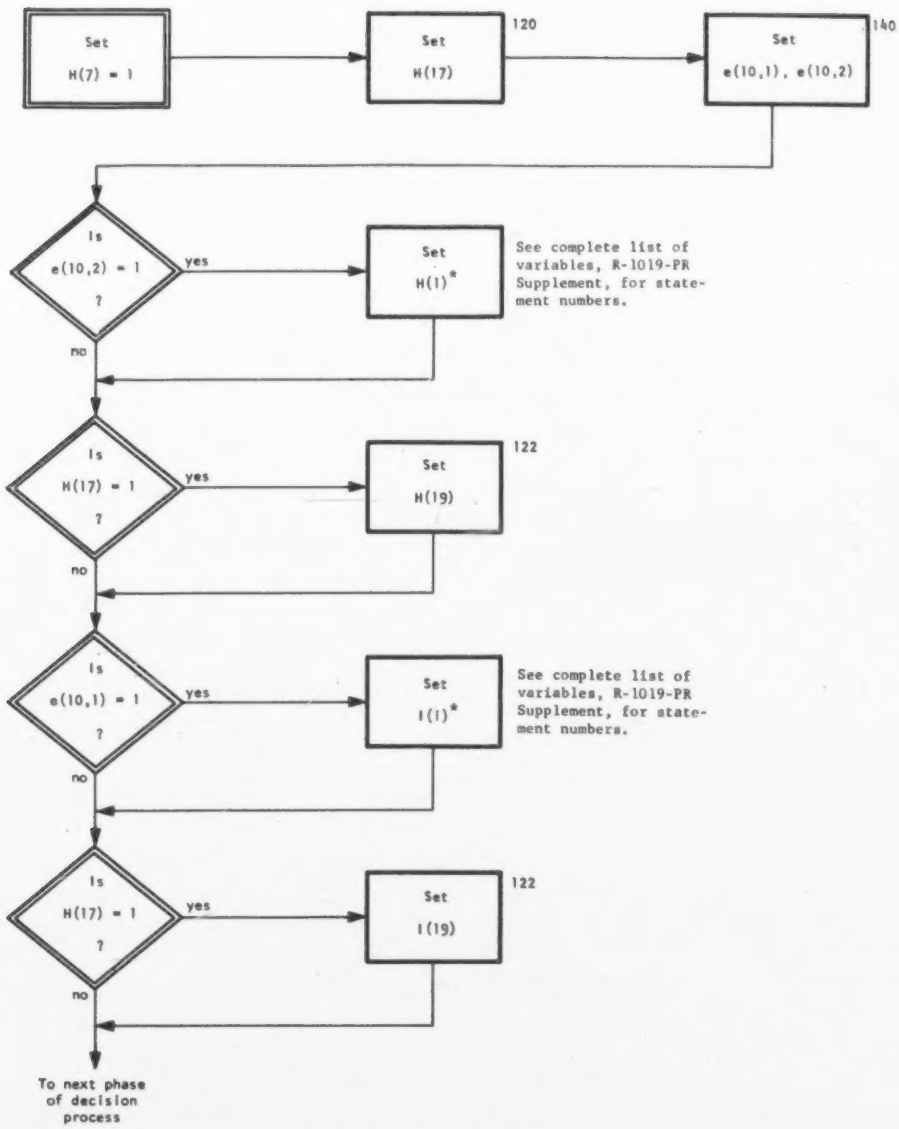
Next, the planner identifies the levels of skill complexity to be taught (3). He may choose either or both of two levels: **relatively simple** and **relatively complex**. A relatively complex skill requires student mastery of a set of *interrelated* skills (such as a checkout procedure). Students may master a relatively simple skill on the first trial or may drill by repeatedly responding to stimuli that an instructor or a presentation device provides.

The decision flows for simple and for complex skills are the same, except at one point (4). If the the skills are relatively simple, we assume that they cannot be demonstrated or directed in any practical way step by step. Therefore, the decision about whether to include follow-me demonstrations (5) is made only for relatively complex skills.

Next, the planner designates the types of responses he wants elicited (6). If students perform any skills of the given level of complexity during scheduled study (7), the computer directs the planner through the decision flow of Fig. 12a, beginning with (4). If not, the computer directs him to establish strategies for demonstration and unscheduled study (8). This flow is discussed shortly.

If strategy has not been set for each level of complexity (9), the computer directs the planner back through the decisions beginning with (4). If strategy has been set for each level, he proceeds to the wrap-up of Type II instruction, individual skills (10), and thence to the next phase of the decision process. The flow for (10) is also discussed shortly.

Figure 13b contains another flag-variable, A(41), that the computer automatically sets. If A(41)=1, the planner is making decisions concerning relatively complex



*For I = 6, 8, 14, 16, 21, 29, 54, 63, 80, as appropriate.

Fig. 12b—Program flow for setting variables for scheduled Type II instruction

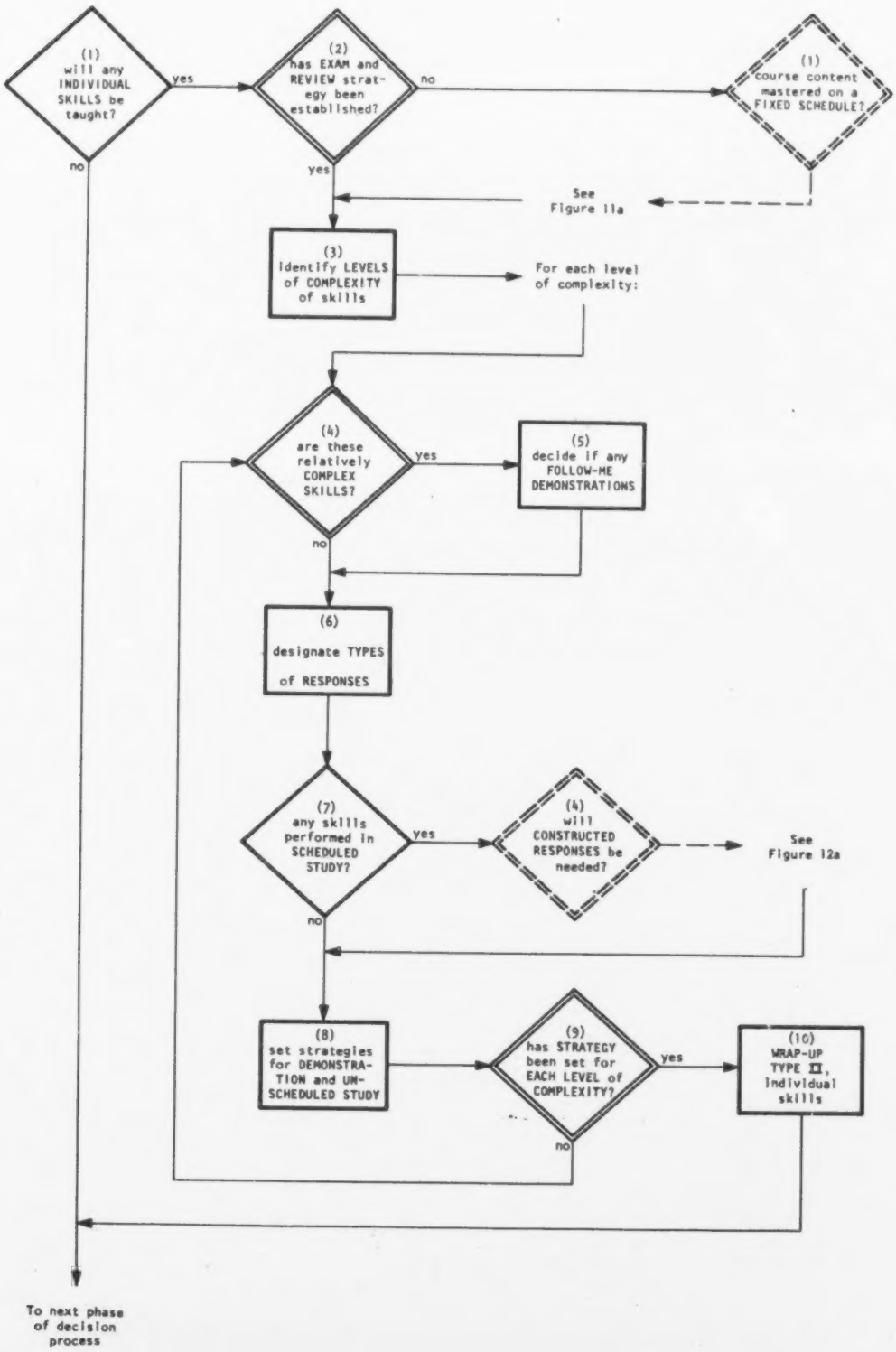

(1) will any INDIVIDUAL SKILLS be taught?
yes
no
(2) has EXAM and REVIEW strategy been established?
no
yes
(1) course content mastered on a FIXED SCHEDULE?
See Figure 11a
(3) Identify LEVELS of COMPLEXITY of skills
For each level of complexity:
(4) are these relatively COMPLEX SKILLS?
yes
no
(5) decide if any FOLLOW-ME DEMONSTRATIONS
(6) designate TYPES of RESPONSES
(7) any skills performed in SCHEDULED STUDY?
yes
no
(4) will CONSTRUCTED RESPONSES be needed?
See Figure 12a
(8) set strategies for DEMONSTRATION and UNSCHEDULED STUDY
(9) has STRATEGY been set for EACH LEVEL of COMPLEXITY?
yes
no
(10) WRAP-UP TYPE II, individual skills
To next phase of decision process

Fig. 13a—Decision sequence for Type II instruction, individual skills

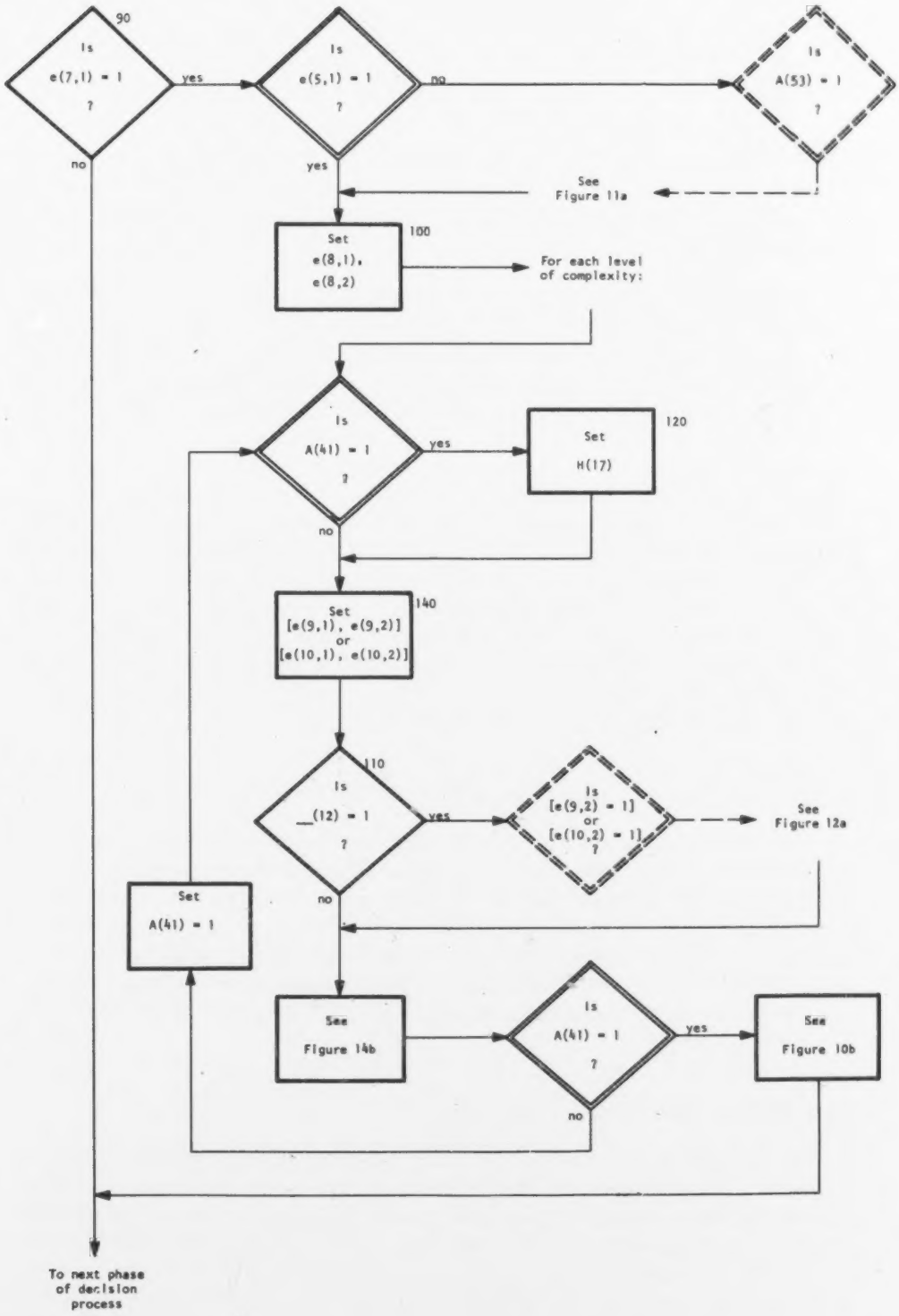


Fig. 13b—Program flow for setting variables for Type II instruction, individual skills

skills. If A(41)=0, relatively simple skills are being considered. If A(41)=0, e(9,1) and e(9,2) are set and tested in the lower part of the chart. If A(41)=1, e(10,1) and e(10,2) are involved.

Demonstrations of Models of Performance and Unscheduled Study, Individual Skills.

Decisions concerning demonstration and unscheduled study are made for each level of skills taught (Fig. 14a). If decisions concern relatively complex skills or if the planner indicates that any student performance will be carried out during scheduled study (1), the computer automatically determines that all presentations of models of performance are made during scheduled study (2). This is because of the importance of initiating students to the skills they are to master. Otherwise, the planner may decide whether such presentations are presented during unscheduled study (3). In any case, the presenter of models of performance is chosen next (4).

If any performance is assigned for unscheduled study (5), the planner is routed through two separate sequences, one for skills that permit selected response (6) and (7), and one for those that do not (8) and (9). Then the same sequence of decisions on random access, scheduling discussions of assignments, and so on, that were required for Type I instruction is followed, beginning with (11) of Fig. 10a.

The planner is then routed to (9) of Fig. 13a to repeat the sequence if strategy is not set for each level of complexity, or if it has, to wrap-up Type II instruction.

The text discussing Fig. 13b also applies to Fig. 14b.

Wrap-Up of Type II Instruction, Individual Skills

The flow for the wrap-up of Type II instruction for individual skills is similar to that shown on Fig. 10a for Type I instruction. Changes are as follows: If strategy is established for scoring deskwork [(1)-(3) on Fig. 10a] or for discussing media presentations [(4)-(6) on Fig. 10a] in the course of setting Type I strategy, the same strategy is applied to Type II instruction where appropriate. Therefore, these decisions would not have to be made again. Also, because the decisions concerning unscheduled study will already have been made, the decision sequence [(8)-(13) on Fig. 10a] is deleted.

Type II Instruction, Interactive Skills

The decision sequence in Fig. 15 concerns teaching interactive skills in Type II instruction. Since the essential part of this instruction involves groups of students working together, the only requirements for communication media are to provide models of the skills to be mastered [(1) and (2)] and to record student performance [(3) and (4)]. We assume that all instruction in interactive skills takes place during scheduled study because of the difficulties of coordinating student performance for unscheduled study. No strategy for formal evaluation of interactive skills is pro-

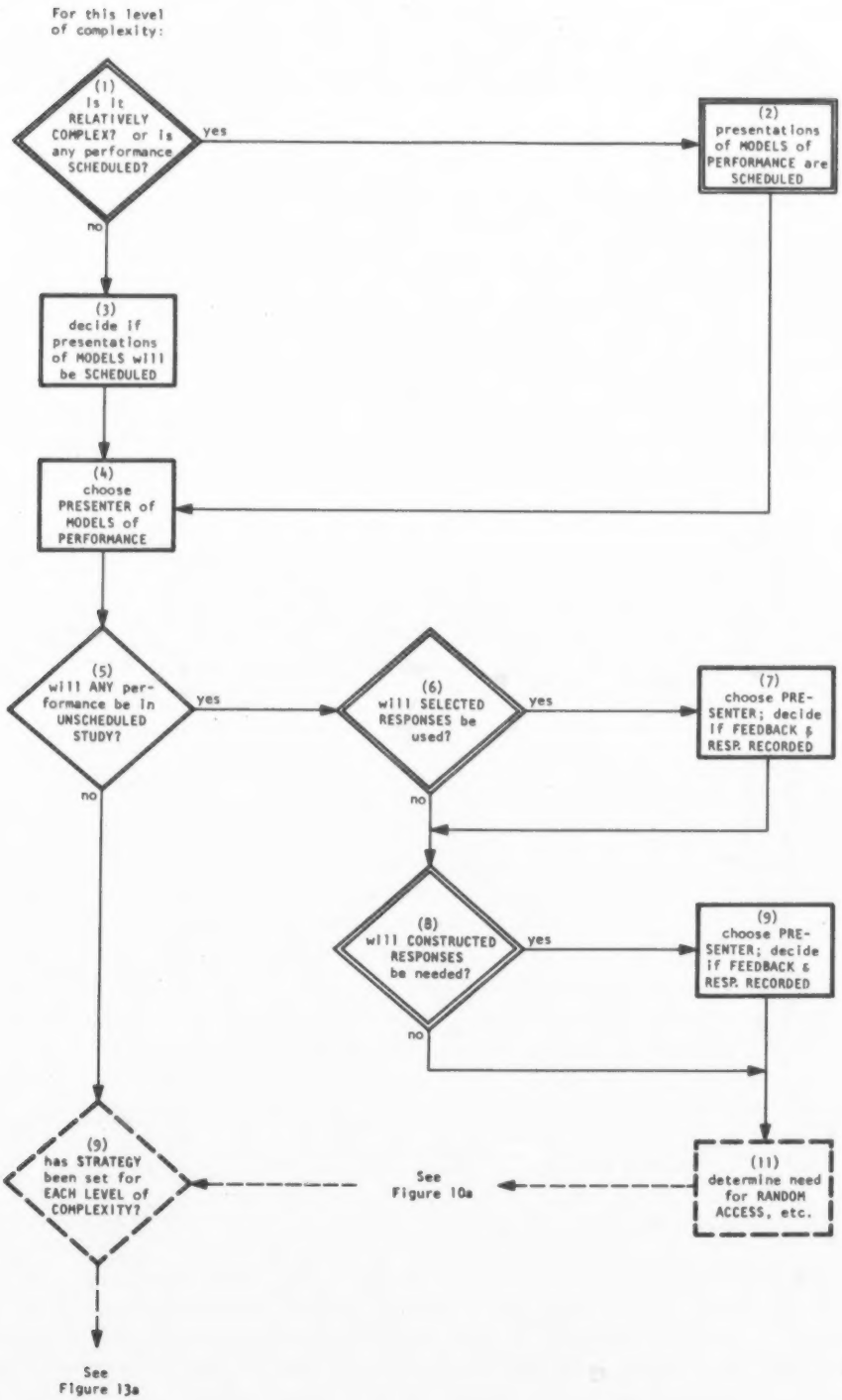

For this level of complexity:
(1) Is it RELATIVELY COMPLEX? or Is any performance SCHEDULED?
yes
no
(2) presentations of MODELS of PERFORMANCE are SCHEDULED
(3) decide if presentations of MODELS will be SCHEDULED
(4) choose PRESENTER of MODELS of PERFORMANCE
(5) will ANY performance be in UNSCHEDULED STUDY?
yes
no
(6) will SELECTED RESPONSES be used?
yes
no
(7) choose PRESENTER; decide if FEEDBACK & RESP. RECORDED
(8) will CONSTRUCTED RESPONSES be needed?
yes
no
(9) choose PRESENTER; decide if FEEDBACK & RESP. RECORDED
(9) has STRATEGY been set for EACH LEVEL of COMPLEXITY?
See Figure 10a
(11) determine need for RANDOM ACCESS, etc.
See Figure 13a

Fig. 14a—Decision sequence for demonstration and unscheduled study

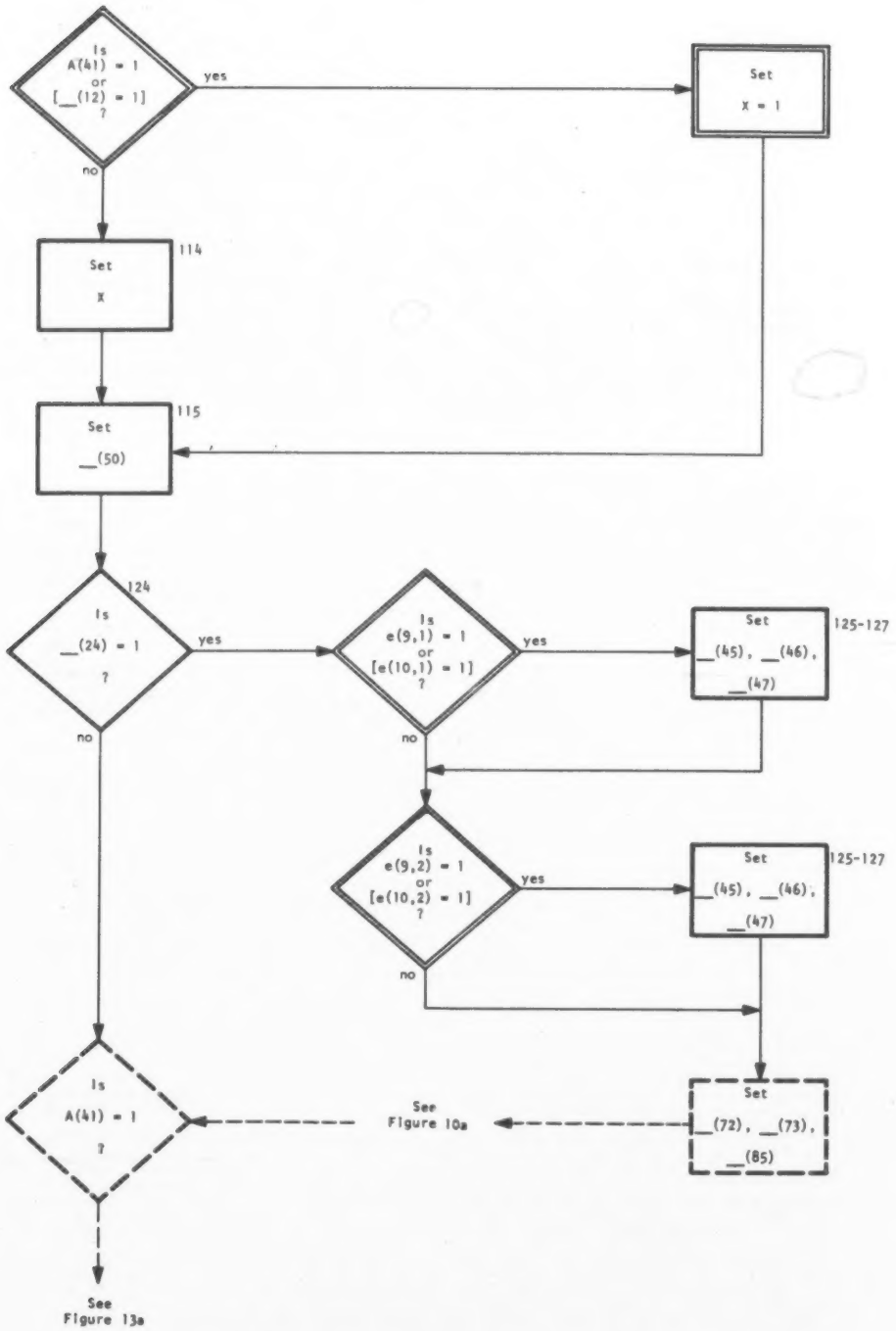


Fig. 14b—Program flow for setting variables for demonstration and unscheduled study

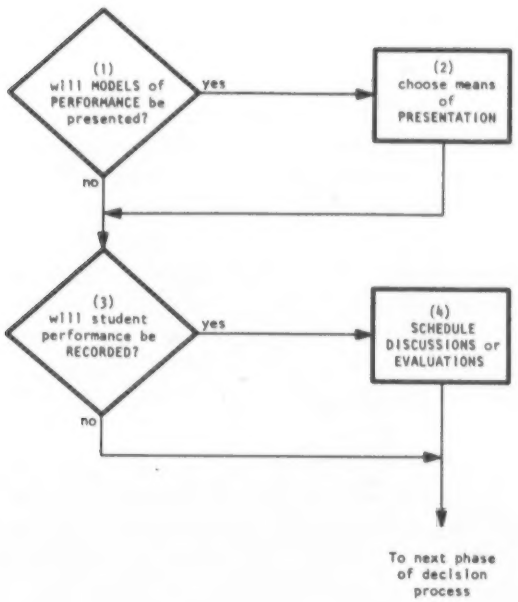


Fig. 15—Decision sequence, Type II instruction, interactive skills

vided, because we assume that whatever evaluation is done would be provided on the spot by the instructor or upon review of recorded student performance.

The program for this decision sequence has not yet been written.

STRATEGIES FOR TYPE III INSTRUCTION

Although the program for Type III instruction is not worked out, the general structure is fairly clear and similarities and differences among the three types of instruction can be noted. First, because Type III instruction is directed toward developing skills, it will be similar to Type II instruction as far as the logical structure of the decision process is concerned. Therefore, decisions will be needed concerning the complexity of skills, the type of response for checking and diagnosing student mastery, the need for demonstrations, and the possible requirement for follow-me demonstrations for complex skills. The flow of these decisions will be essentially the same as that for Type II instruction.

There will be some differences, though. First, a skill demonstration for Type II instruction will never require the use of special facilities or equipment; however, initial skill demonstrations taught by Type III instruction will *always* require the

use of special facilities or equipment. If these demonstrations are presented by a communication medium (rather than live), they may be shown in the classroom and will be similar in their requirements for system support to Type I presentations that require special facilities or equipment. But unlike Type I presentations, the facilities and equipment required for the demonstration will always be available at the school. Therefore, dollar savings will be of less concern than considerations of effectiveness in deciding whether the demonstration should be given live. The average instructor may be relatively inept at structuring and explaining a demonstration; in that case, other means for accomplishing this crucial step may be preferable.

In follow-me demonstrations of complex skills, each student requires access to the special facilities or equipment needed to execute the skill. Therefore, these communications must be given in the appropriate environment. If that environment demands the presence of an instructor or monitor to assure the safety of students, the equipment, or the surrounding area, the most reasonable choice for the presenter may well be the instructor or monitor. Whether or not his presentation is prepared for him in advance then becomes the important issue as far as communication media systems are concerned. If an instructor is *not* required and individual skills are taught, communication media systems can be highly effective when used for follow-me demonstrations.

The considerations for teaching interactive skills in Type III instruction are similar to those for Type II. The major difference will be determining whether demonstrations should be executed in the Type III environment or whether they would be more effective via a communication medium.

Not all student responses in Type III instruction are necessarily constructed. For example, selected responses can often be used to trace the student's progress through a checkout procedure or to determine whether he can identify the location of particular equipment on an aircraft. (The latter activity could be considered Type I instruction if the designer does not feel that experience with an actual aircraft is essential to learning.) By and large, however, student responses in Type III instruction are constructed and require the judgment of an instructor, monitor, student leader, or the student himself to assess their rightness. Determining how to provide this feedback to the student is thus an essential part of the system design. Communication media can often be used to provide models of accepted practice; they cannot be used to assess the acceptability of the students' responses.

The strategy for unscheduled study will depend heavily on the school's policy with regard to unscheduled student access to special facilities or equipment needed. Where safety is a consideration, probably no unscheduled study will be planned. If safety is not an issue, the expense of keeping facilities open or of making equipment available may be a deterrent. Students who are turned on by the Type III instruction (and many students find this type of training highly stimulating) may well want to work extra hours with the equipment. The same arguments apply to the decision about whether review should be scheduled or unscheduled.

An important issue in technical training concerns the formal examination for Type III instruction. In many instances no time is set aside specifically for such examination; rather, the instructor is expected to judge the students' competence

during the course. Although this may be an effective solution if the instructor is trained to observe completely and objectively, most instructors are probably not as competent in this respect as would be desirable. Job performance tests, however, are notoriously expensive to administer and difficult to score reliably. Reliable scoring may require a team of observers, adding more expense. Lacking the analysis that would show whether such elaborate tests are worth their cost in the long run, we must rely on the informed judgment of the planner at this point.

GENERAL STRATEGIES

Figure 16a shows the decision flow for setting general strategies. As mentioned earlier, DISTAF treats adaptivity of two different kinds—adapting course content and adapting instructional method. The planner may choose to adapt course content to student background in answering the Questionnaire for Stating General Policy (1); if so, the computer directs him to choose the basis for selecting students for the modified courses (2). If not, the computer checks whether the planner wants to adapt teaching method to student capabilities (3), a decision he will also have made in answering the Questionnaire.

If the planner chooses to adapt the instructional method, the computer next checks to see whether he also chooses to use tracking (4). Without tracks, the planner may decide to adapt teaching method for only parts of the course (6) because he wants all students to share certain learning experiences. For example he may feel that a particularly skillful instructor in his school should teach a part of the course to every student who takes it because this instructor is adept at motivating students.

If students are put into tracks, the planner may wish to use an instructor with a special background for a slow track or for a fast track (5). If a special instructor is selected for the slow track, it is assumed that he will be responsible for designing the instruction appropriate for his class. For the bright group, the student himself or perhaps a student leader can be responsible for adapting the *way* he learns to *what* he learns. If tracking is not chosen (presumably because the designer wants to preserve an option to adjust groupings to the type and difficulty of the instruction), it is probable that scheduling difficulties will make it too inconvenient to hire special instructors for brighter or slower groups as the instruction requires.

In Stating General Policy, the planner may decide to allow slower students to repeat portions of the course or to receive remedial instruction as needed. If so (7), the computer directs the planner to provide either remedial instruction or to allow repeats or both. If he provides remedial instruction (8), he next decides whether to give it in scheduled sessions or to assign it for unscheduled study (9). For scheduled remedial sessions he chooses the presenter and estimates the time the session will require (11). For unscheduled remedial sessions, no decisions are necessary; these sessions will be conducted in the same way as other unscheduled study (10).

Again, the computer checks to see whether teaching method will be adapted to student capabilities (12). If not, the planner may choose at least the limited adap-

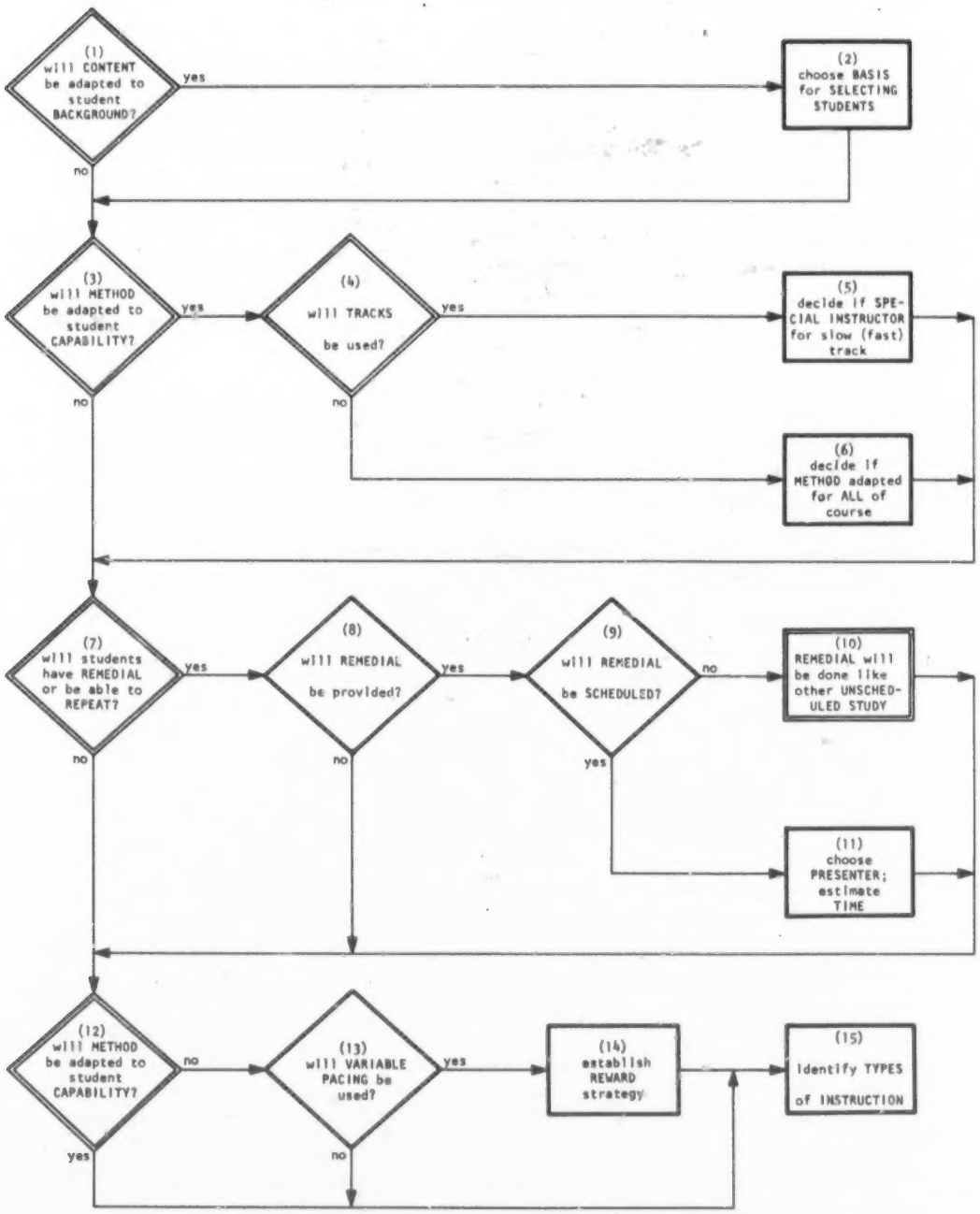


Fig. 16a—Decision sequence for general strategies

tivity offered by variable pacing (13). If he does, the planner must establish a strategy for rewarding students who complete their studies (14). Rewards may be needed to provide continuous, high motivation in many school situations. Finally, the planner identifies the types of instruction (Types I, II, and III) for his course (15). This completes this phase of the decision process.

Figure 16b is self-explanatory.

Shortcuts in the Decision Process

Throughout the program are points at which the planner may apply a strategy he has set previously to the instruction under consideration or he may devise a new strategy for it. If the applicable strategy was just set, the computer asks if the planner wants to change it. If the applicable strategy was set several steps before, the computer types out a few phrases to remind the planner of the applicable strategy.

This device was introduced so that a planner does not have to work through all decisions if he does not wish to do so. To make it a reasonable tactic, we identified the types of instruction that are sufficiently similar that a planner might want to use the same strategy for both. Table 6 shows the matchings currently built into the program. The column headed key variable(s) lists the main variable(s) the planner should consider in deciding whether or not to apply the same strategy to similar instruction. If the key variables are *all*, the program sets all decision variables in the similar instruction equal to those in the instruction with established strategy. If the key variables are not all, only certain sets of variables are changed. These are discussed shortly. The column headed *program reminder?* notes whether or not the computer recalls the previous decisions on the key variables for the planner.

Similarity is determined primarily on the basis of type of instruction (lines 1, 2, 12, 13) and level of difficulty (lines 3 to 11). Currently, simple Type II is treated as though it were relatively easy; complex Type II, as difficult. Presentation of models of performance in Type II instruction (lines 14 to 17) are an exception. Here, the presentation is assumed to be similar to the instruction requiring constructed response (if the planner has described any) because that instruction usually requires more latitude in presentation and because demonstration does not call for response. If there is no Type II instruction (simple or complex) requiring constructed response, the demonstration is assumed similar to the Type I instruction of a similar level of difficulty.

If the applicable strategy has not been established, as would be the case, for example, if no difficult Type I instruction was in the course but complex Type II was (lines 4, 5, 7, 9, 11, 17), then the program skips the question and begins determining strategy for the instruction at hand. Other reasons for skipping the "similar strategy" questions are the following:

- A decision not to adapt teaching method in Type I instruction but to do so in Type II, or vice versa (lines 3 and 4).

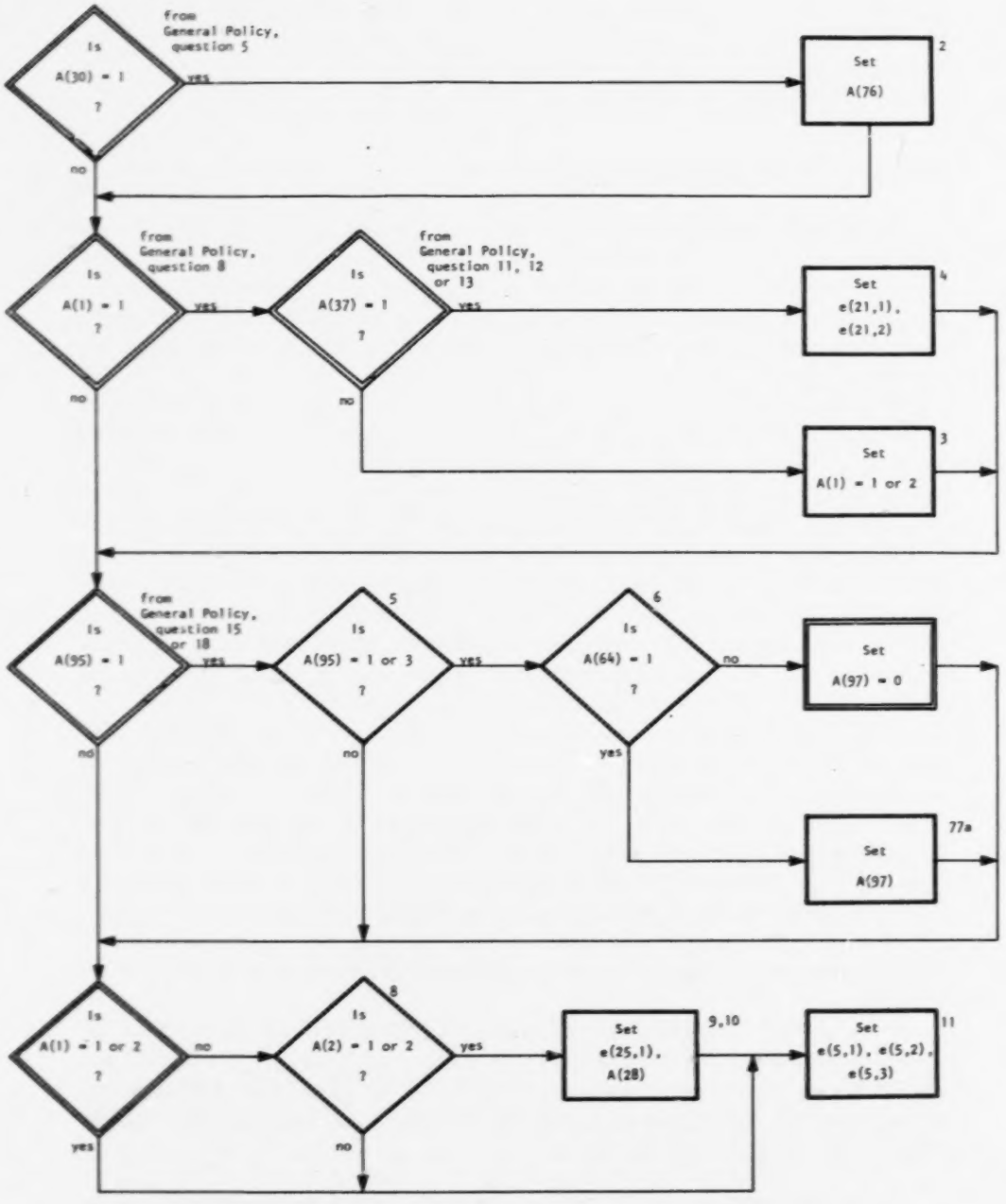


Fig. 16b—Program flow for setting general strategy variables

Table 6

TYPES OF INSTRUCTION MATCHED FOR DECIDING STRATEGY CHANGES

Instruction with Established Strategy	Similar Instruction; Strategy to be Established	Key Variable(s)	Program Reminder?
1. Easy Type I	Difficult Type I	All	No
2. Simple Type II	Complex Type II	All	No
3. Easy Type I	Simple Type II	Grouping	Yes
4. Difficult Type I	Complex Type II	Grouping	Yes
5. Difficult Type I	Complex Type II	Variable pacing	Yes
6. Easy Type I	Simple Type II with constructed response; Simple Type II with selected response	Adaptor and presenter for each group	Yes
7. Difficult Type I	Complex Type II with constructed response; Complex Type II with selected response	Adaptor and presenter for each group	Yes
8. Easy Type I	Simple Type II with constructed response; Simple Type II with selected response	Pacer and presenter	Yes
9. Difficult Type I	Complex Type II with constructed response; Complex Type II with selected response	Pacer and presenter	Yes
10. Easy Type I	Simple Type II with constructed response; Simple Type II with selected response	Presenter	Yes
11. Difficult Type I	Complex Type II with constructed response; Complex Type II with selected response	Presenter	Yes
12. Simple Type II with constructed response	Simple Type II with selected response	All	No
13. Complex Type II with constructed response	Complex Type II with selected response	All	No
14. Simple Type II with constructed response	Presentation of models, simple Type II	Presentation	Yes
15. Easy Type I	Presentation of models, simple Type II	Presentation	Yes
16. Complex Type II with constructed response	Presentation of models, complex Type II	Presentation	Yes
17. Difficult Type I	Presentation of models, complex Type II	Presentation	Yes

- Establishment of one set of groups to facilitate adapting teaching method for Type I instruction and a different set for Type II (lines 6 and 7).
- A decision not to use variable pacing in Type I instruction but to do so in Type II, or vice versa (lines 8 and 9).
- Use of a presentation method that requires selected response (such as a teaching machine) in Type I instruction (lines 6 through 11).

The parallel question to line 5 that would match average-to-easy Type I instruction with simple Type II in inquiring whether variable pacing is to be used does not appear because simple Type II instruction can include drills in which variable pacing is used initially until the student learns the correct responses. Then a fixed pace is used to bring the student up to some desired rate of response (speed drills). This introduces a variation that reduces the similarity of average-to-easy Type I instruction to simple Type II instruction.

If a follow-me demonstration is used in complex Type II instruction, its particular requirements should be considered separately, not as part of the complex Type II package. Therefore, line 13 is skipped if follow-me demonstrations are used.

We have not fully determined which strategies in Types I and II instruction are similar to those in Type III instruction. At this point, the decision concerning presentations of Type I instruction that require special facilities or equipment seems to be the only one applicable to Type III instruction. It would, of course, be similar to the decision concerning pure demonstration, but since the facilities or equipment required for the demonstration would be available, the considerations would be different.

Several other assumptions were used to keep the number of "similar strategy" questions to a reasonable level. For example, if the designer establishes groups to facilitate adapting instructional method, it is assumed that he will want to consider each group separately in establishing strategy. He may establish the same strategy for each group if he wishes, but this decision is not facilitated by "similar strategy" questions.

VI. CONCLUDING REMARKS

PRESENT STATUS OF THE DECISION PROCESS

The work described in this report has reached a point where it can help people involved in planning and designing programs of instruction. There are at least three areas in which further development would be profitable, however:

- Extracting the details of the decision process for Type III instruction, i.e., student performance in special facilities or with special equipment.
- Reprogramming DISTAF in a more generally accessible language.
- Subjecting the decision process to field evaluation by potential users to assure its utility.

As noted earlier, setting strategy for Type III instruction will probably follow much the same logic as that for Type II. There is a point of significant difference, however, in that it is difficult to evaluate student mastery of Type III instruction reliably and inexpensively. Consequently, evaluation is often slighted in planning this type of instruction; frequently, such evaluation is left to the discretion of the individual instructor, which is hardly an assurance against biased results. Therefore, for Type III instruction a set of alternatives to this approach needs to be devised and included as part of the design methodology. Wherever possible, the use of technological aids to evaluation will be among the alternatives available.

At present, DISTAF is programmed in JOSS, a language that is not widely accessible. To improve accessibility, the Rand team is reprogramming DISTAF into Interactive FORTRAN, a language that will be usable on many time-shared systems and that is more versatile than BASIC, the other widely used language of time-shared systems.

Finally, potential users should test the decision process to determine whether:

- Strategy questions are stated in terms the user comprehends.
- Strategy questions are stated in ways that elicit positive and imaginative responses.
- All strategy approaches of interest to users are included.

- The program contains enough reminders so that the user knows what he is working on at each decision point.
- The time required to learn the process is short.

PRESENT USES OF THE DECISION PROCESS

In its present state, the decision process can be used in several ways. First, anyone can use it who has access to JOSS to specify strategies of instruction that deal largely with subject matter suitable for the classroom. Strategy specifications of these types can be useful in providing the ground rules for designing instruction using some of the newer technologies such as computer-assisted or computer-based instruction or cable television.

Even without the assistance of JOSS, the User's Manual provides a checklist of points to consider in planning and designing programs of instruction. By assembling, in one consistent list, most of the considerations surrounding alternative approaches to designing programs of instruction, the manual should help assure the planner that he has dealt with all significant points in terms of resource use.

Finally, the manual can be used in reverse; that is, as a checklist for describing actual instruction. In this role the manual can help to define observed teaching strategies that link school resources to student learning. Such definitions may assist in determining whether and how school resources affect student learning, an issue that has been a matter of serious debate for some years.[19]

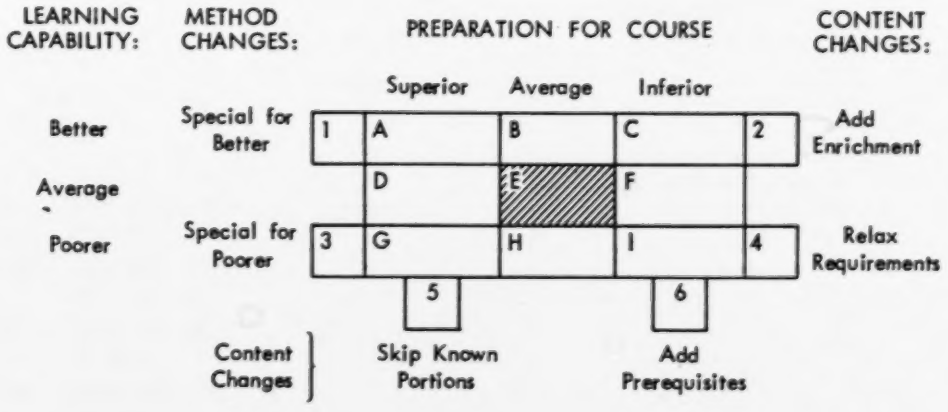
[19] J. S. Coleman, et al., *Equality of Educational Opportunity*, U.S. Department of Health, Education, and Welfare, U.S. Office of Education, OE-38001, Washington, D.C., 1966.

Appendix A

QUESTIONNAIRE FOR STATING GENERAL POLICY

As described in Sec. II, this Questionnaire enables the planner to consider policies in three general areas: the broad characterization of the teaching institution's goals, the extent to which the schools will adjust to variations in the student population, and the way in which the schools must accommodate their operations to the needs of organizations that supply their students or accept their graduates. Each of the 17 questions have "yes" or "no" answers, with directions to follow according to the answer given.

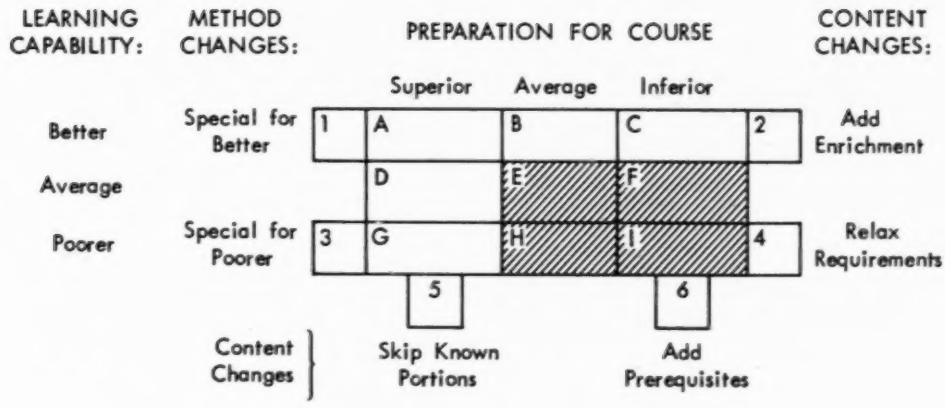
As you go through the Questionnaire, you may be asked at certain points to check numbered boxes on the chart below. If you answer question 13 "yes," you will be given further instructions about how to complete this chart, which is a guide in preparing the course for the type of student population desired. If you do not answer question 13 "yes," you will not need this chart further.



	YES	NO
1. Will a standard number of instructional hours be required as input, regardless of course content or student capability?	☐ Stop	☐ Proceed
2. Are standardized graduates desired?	☐ Go to 5	☐ Proceed
3. Will better students be encouraged to go beyond average achievement?	☐ Check box 2 Proceed	☐ Check box 4 Go to 5
4. Will requirements be relaxed for poorer students?	☐ Check box 4 Proceed	☐ Proceed
5. Will exposure to course content be matched to prior student achievement?	☐ Proceed	☐ Go to 8
6. Will additional instruction be given to students who are deficient in course prerequisites?	☐ Check box 6 Proceed	☐ Check box 5 Go to 8
7. Will students with superior preparation be allowed to skip topics they already know?	☐ Check box 5 Proceed	☐ Proceed
8. Will different instructional strategies be designed to match different student capabilities?	☐ Proceed	☐ If 5 = YES and 2 = YES, go to 13 If 5 = YES and 2 = NO, go to 11 If 5 = NO and 2 = YES, go to 14 If 5 = NO and 2 = NO, go to 12

	YES	NO
9. Will special strategies be used for better students?	☐ Check box 1 Proceed	☐ Check box 3 If 5 = YES, go to 11 Otherwise, go to 12
10. Will special strategies be used for poorer students?	b Check box 3 If 5 = YES, proceed Otherwise, go to 12	b If 5 = YES, proceed Otherwise, go to 12
11. Will students be put into tracks?	☐ Proceed	☐ Go to 14
12. Will students be put into tracks on the basis of their learning capability?	☐ If you answered 11, proceed If you did not answer 11, go to 17	☐ If you did not answer 11, go to 14 If you answered 11, go to 17
13. Will students be put into tracks on the basis of their preparation for the course?	☐ Follow directions on next two pages to determine how you want to put students into tracks Go to 17	☐ Go to 17

Unless you answered "yes" to question 13, skip this information. Refer to the first page of this Questionnaire and lightly shade all *lettered* boxes within the chart for which you have *not* entered a check in neither the corresponding numbered boxes at the sides of the rectangle *nor* in the corresponding numbered box at the bottom. For example, if you entered a check in boxes 2 and 5, you would shade boxes as shown below (i.e., E, F, H, and I).



The boxes you shade represent students who will be taught all of the basic course content by a method designed for the student of average learning capability. These students are logical candidates for a single track (there may be several classroom groups within a track).

Students in the unshaded boxes are candidates for other tracks. In forming these tracks, you will want to remember two principles. First, the objective of tracking is to facilitate instruction by forming relatively homogeneous groups of students. Therefore, you might hesitate to put students in box G in the same track with those in box A. Second, planning will be simplified and resource use more efficient if the number in each track is greater than some minimum. What this minimum should be depends on the average classroom size in the school. For example, if classroom sizes are around 10, a minimum of 5 might be reasonable, but if classroom sizes are around 30, perhaps a minimum of 15 might be reasonable.

Finally, if you cannot reconcile the requirements of homogeneity and track size, you may want to group students within tracks or completely individualize instruction to take account of student differences.

After the tracking configuration is determined, designate what the configuration will be by listing the letters of the boxes that will form each track on the form below. After each set of letters, check whether or not within-track grouping will be used for that track. (Complete individualization will be considered to be a variant of within-track grouping.)

Letters of Boxes in Track	Within-Track Grouping? Yes	No
1. _____	☐	☐
2. _____	☐	☐
3. _____	☐	☐
4. _____	☐	☐
5. _____	☐	☐
6. _____	☐	☐
7. _____	☐	☐
8. _____	☐	☐
9. _____	☐	☐

	YES	NO
14. Will basic course content be presented on a fixed schedule?	☐ Proceed	☐ Stop
15. Will additional resources in the form of remedial instruction or washback be used for slow students or students who have been absent?	☐ Proceed	☐ Proceed
16. Will failing students be dropped from the course before its conclusion?	☐ Stop	☐ Stop
17. Will basic course content be presented on a fixed schedule within tracks?	☐ Go to 15	☐ Stop

Appendix B

USER'S MANUAL FOR SPECIFYING INSTRUCTIONAL STRATEGIES

INTRODUCTION

Paragraphs throughout this manual are numbered to correspond with numbers the computer will give you to direct you to a particular topic at a particular point as you progress through the program. A few numbers have been skipped to allow for possible expansion of the program.

1. In conjunction with the time-shared computer program, this manual will help you specify the strategies you wish to use to teach the course described in your general Curriculum Analysis. The decisions you have already made in filling out the Questionnaire for Stating General Policy and the characteristics of the expected student population will first be fed into the computer to guide the time-shared program. Therefore, you will probably not be asked to make every decision that appears in this manual because many will be irrelevant to your particular situation. Even so, it would be wise for you to read the manual carefully before you sit down at the JOSS console so that you will be sufficiently familiar with the manual's contents to have a general idea of what to expect.

For ease of reading without computer assistance, the manual treats decisions affecting the entire course first, and then progresses through the various types of instruction at increasingly fine levels of detail. The computer program does not follow this order strictly, as it seems more natural to make some decisions before making others, even though the latter may be more general than the former.

If you use this manual *without direction from the computer,* you will often encounter statements (such as 2, describing adaptivity) that seem puzzling because they refer to prior decisions you might have entered into the computer in an on-line run. For example, statement 2 refers to a decision entered from the Statement of General Policy.

Each statement in the manual is intended to perform two functions: to present the pros and cons of each choice that you may make at that point, and to indicate some consequences of each choice when the consequences are not immediately

obvious. Hopefully, this will help you to make your choices; for this reason, it is advisable to read the statements carefully as you progress through the program. Because this is a time-shared computer program, you may take as long as you wish to make selections without incurring additional costs at the central processing unit.

The program helps keep track of the category of instruction to which your current decisions pertain by typing out headings as you progress through the logic tree. It also types out phrases that remind you of the specific item you are considering at the time. For example, if you are determining who or what will control pacing in a variably paced course, the computer will type pacer. These points are illustrated in Appendix C, which gives a typical "run" through the program along with an example of program output.

Except in cases with more than two choices for a particular decision (as, for instance, with the pacer), typing *1* means "yes" and typing *0* means "no." If you type an illegal value (i.e., one that is not included in the statement you are reading), in most cases you will be in trouble because limitations on computer storage space do not allow the programmer to build in automatic checks on each statement. Therefore, it is advisable to check each value you type with the list of legal values given in the statement.

In the finished version of the program, if an error occurs, you will be able to return to the point where the nearest heading (or subheading) appears and repeat the decisions in that section to remedy your error. (This capability has not yet been built into the program.) The alternative, to insert the correct value where the error occurs, could be chosen if you know the name of the variable associated with the phrase just typed out. For example, if the value entered for pacer is illegal and decisions are being made for average students and Type I instruction, you could hit the carriage return and type "Set C(14)=1," or whatever your choice might be. This tactic is not advisable for the general user, however, because it requires detailed knowledge of the program to be done successfully.

The capability for building in automatic checks for illegal values depends on the language used and the storage capacity of the computer's compiler. With Interactive FORTRAN and a large enough compiler, this capability may eventually be provided.

At certain points in the program, the computer will type out a phrase or set of phrases to remind you of a particular set of strategy decisions that you made previously and that you may wish to apply to the next set of decisions. The program then asks whether or not you want to make such an application by typing policy change. If 0 is then typed, the set of decisions will automatically be applied to the next set, which you then skip. If 1 is typed, you will be asked to make the next set of decisions.

You are now ready to specify your instructional strategy.

Adaptivity

2. In the Questionnaire for Stating General Policy you decided to adapt course content to the students' prior learning that applies to your specific course. You planned either to allow better prepared students to skip material they already know

or to provide more poorly prepared students with some remedial work on course prerequisities or both.

Now you will decide how to determine which students should receive specialized treatment. Several approaches may be used.

- *Method 1.* Assume that students have certain strengths and weaknesses based on what is known about their background; for example, their scores on relevant sections of the Airman's Qualifying Examination (AQE), their prior Air Force experience, or their similarity to prior student populations in similar courses. This tactic has the advantages of low cost and little effort, but may lead to gross errors in assignment.
- *Method 2.* Gather information on the basis of student performance as the course progresses. This would provide more information than method 1, but it may waste resources in teaching some students what they already know and in identifying students whose preparation is deficient after they have gotten well into the course. If this tactic is selected, you will need to identify the point at which this decision will be made.
- *Method 3.* Give each student a diagnostic pretest to pinpoint his specific strengths and weaknesses and to allow him, his counselor, or his instructor to judge how much effort will be required to attain various objectives and to select and sequence the materials needed. For accuracy, this is probably the best tactic, but reliable and valid diagnostic pretests may not be available.

If you select method 1, type 1; if method 2, type 2; if method 3, type 3.

3. In filling out the Questionnaire for Stating General Policy, you decided to specify different teaching strategies for students of different learning capabilities but not to form special tracks. For some teaching situations, however, you might wish to apply the same strategy to all students, regardless of capability, to foster an esprit de corps even when students are working on individual skills. For example, having all students work together in a shop or lab could simulate the actual working conditions they are being trained for more accurately.

If strategies are tailored to students' learning capabilities for only parts of the course, type 1; if for *all* of the course, type 2.

4a. In the Questionnaire for Stating General Policy you decided to specify different teaching strategies for students of different learning capabilities by putting poorer students in a separate track. To assist slower learners, sometimes a specially trained instructor is used, such as a remedial reading specialist. A special instructor will be responsible for designing the appropriate instruction for his class.

If special instructors will be assigned to the slow group, type 1; if regular staff, type 0.

4b. In the Questionnaire for Stating General Policy, you decided to specify different teaching strategies for students of different learning capabilities by putting better students in a separate track. Special instructors, such as those with a stronger intellectual orientation, might be used to stimulate bright students. Such instructors may even guide their students in designing their own courses of study.

If special instructors will be assigned for the bright group, type 1; if regular staff, type 0.

5. In the Questionnaire for Stating General Policy, you decided to provide additional instructional resources for slower students either by giving them remedial work or by allowing them to repeat sections of the course that they failed. Remedial work can complicate scheduling by putting varying burdens on instructional resources. If students are sufficiently mature, however, remedial work can be carried out in unscheduled study without involving instructors. Allowing students to repeat failed sections is a less efficient tactic but may be simpler to implement.

If remedial work will be provided, type 1; if students will be allowed to repeat sections of the course, type 2; if both tactics will be used, type 3.

6.* If remedial work will be carried out in scheduled sessions outside of regular class hours, type 1; if remedial assignments will be made for unscheduled study, type 2.

7a.† This preliminary program will provide only two choices for the scheduled presentation of remedial exercises and materials—either the strategy will be the same as that you select for scheduled basic instruction or an instructor will be responsible for remedial sessions. If you decide (later) to schedule *no* basic instruction, the design program will automatically assign an instructor for conducting remedial sessions, whichever choice is made here.

If an instructor will conduct remedial sessions, type 1; if the same strategy will be applied as that for basic instruction, type 0.

Type the time that the average student will require for scheduled remedial sessions as a percentage of the time required for the basic instruction for which students will need remediation. For example, if the topic treated in a 6-hour session is particularly difficult, poorer students may need a 1½ hour remedial session, which would add 25 percent to the time required for the basic instruction.

7b.‡ This preliminary program will provide the same strategy for remedial exercises and materials for unscheduled study as that you select for other assignments for unscheduled study. If you later decide to exclude unscheduled study in a major part of the course, you will return to 7a.

Variable Pacing

8. Although you do not want to adapt teaching methods to the needs of individual students, as decided in the Questionnaire for Stating General Policy, you can still pace the presentation of course content to match students' learning rates. Variable pacing allows considerable adjustment to student needs because, in effect, it allows the fast student to skim materials he is already familar with and gives the slow student time to mull over what he needs to.

Variable pacing can be accommodated even within a fixed schedule by using

* To be answered only if the answer to statement 5 is 1 or 3.
† To be answered only if the answer to statement 6 is 1.
‡ To be answered only if the answer to statement 6 is 2.

remedial sessions for slow students and giving free time to bright students. Since the intent of using variable pacing as an instructional strategy is to match the rate of the instruction to the student's learning rate, some means is required for checking student mastery of the material as he goes along. Therefore, an automatic consequence of choosing variable pacing is that stimuli for overt student response must be integrated into the presentation of material; that is, the materials must be "programmed" so that the "pacer" (instructor, adaptive program, or the student himself) will have a basis for pacing. Writing materials for variable pacing is much more demanding and costly than writing materials for straight presentation.

Indicate at this point whether you want the entire course variably paced by typing 1, whether you want some parts variably paced by typing 2, or whether you want nothing variably paced by typing 0.

9a. In some situations, students are so highly motivated to complete their studies that they do not need additional incentives to keep up their learning rate in a variably paced course. Since you chose in the Questionnaire for Stating General Policy to have the overall course schedule be fixed, however, students may not care whether they finish a lesson or series of lessons quickly. If this is true, students may need additional incentives to put their best efforts into their work.

If additional rewards will be needed for motivation, type 1; if not, type 0.

9b. Because you chose in the Questionnaire for Stating General Policy to have the overall course schedule be variable, students may be highly motivated to complete their studies quickly so that they may go on to more challenging work or to other pursuits. If the school environment is relatively pleasant, however, they may even have reason to dally. In this case, students may need additional incentives to put their best efforts into their work, or a monitor may be used to oversee student work during study periods.

If additional incentives will be provided for motivation, type 1; if not, type 0.

10. Rewards may consist of material objects, bestowal of status (symbolic or real), or additional free time. If free time is given as a reward, there may be little saving in the amount of time a student requires to complete the work, although the time devoted to scheduled instruction may decrease, with a resultant saving in the time put in by instructors, monitors, and so on.

If rewards will include additional free time, type 1; if not, type 0.

Types of Instruction

11. Now you will be asked to identify the major types of instruction that you will need. (Refer to the definitions below.)

Type I Instruction. Instruction that requires no student use of special equipment and no student performance in special facilities. In addition, students are not acquiring skills (cognitive, psychomotor, motor, or social) through drill or practice. Type I activities typically occur in the classroom and concern the presentation of facts or concepts for the student to master or the presentation of goals or objectives to motivate him with a sense of direction for his learning. Frequently includes

affective objectives (such as changes in attitude toward the subject) and demonstrations. Most Type I instruction involves presentations, and may or may not contain integrated stimuli that require overt student responses.

Type II Instruction. Like Type I instruction requiring no special facilities or equipment for student performance; however, students master skills that require drill, practice, or performance. The student learns to make particular responses when provided with directions and stimuli. Activities are those in which the student must do something besides answer questions. Also includes the presentation of models of skills to be mastered (even though no student performance may be required during the demonstration) because demonstrations are frequently given immediately preceding student performance. Therefore, it may often be convenient to use the same means to present the models as those used to present directions for performance or actual drill stimuli. If a performance model is to be given but not immediately preceding or concurrent with the drill, practice, or performance session, it may be categorized as a segment of Type I instruction.

Type II instruction can include pure skill demonstrations (with no student response); follow-me demonstrations (or step-by-step directions) in which the students perform each step as they are directed or as each step is presented; presentation of directions and stimuli for performance; and pure performance (with no presentation to the student). The distinction between the latter two categories is implicit in the Curriculum Analysis which estimates the time required for presentation.

Type III Instruction. Any instructional activity that requires the students to work with special equipment (such as a simulator, a piece of machinery, or a musical instrument) or in a special facility (such as a shop, a laboratory, a parade ground, or other special area) or both. The instructor is *not* using Type III instruction when he uses special equipment (such as a projector or mockup) to demonstrate a procedure or to clarify a concept (such as operating aircraft flight controls) unless the students are also required to use the same equipment at the same time (or immediately afterward). The rules for classifying performance models and presentations for Type III instruction are the same as those for Type II instruction, namely, if the model immediately precedes or is concurrent with the student performance, it is most conveniently treated as Type III instruction; if the model will be separated in time from the student performance, it may be treated as Type I instruction.

If Type I instruction will be used, type 1; otherwise, type 0. Use the same code for Type II and Type III instruction.

Instructional policy is now set for each type of instruction that appears in the course. This policy will cover all aspects of the course, including assignments for independent study that will be preplanned and prepared ahead of time.

ALL TYPES I AND II INSTRUCTION

Formal Examinations

15. Now you will set a general policy for the frequency and content of formal examinations. (The program excludes any examination activity that does not require time during the teaching day, such as grading papers at home. The instructional time required for checking a homework assignment is treated as part of the policy for unscheduled study or homework.)

If students are not required to master course content on a fixed schedule, it is impossible to schedule examinations covering a given set of topics for fixed time intervals. Therefore, statement 15a will be read if a fixed schedule will *not* be used; otherwise, statement 15b will be read. These set the stage for statements 16 through 20.

15a. The best basis for establishing an examination schedule to check student progress is the course content itself. As used here, topic means a unit of content. Several related topics may be grouped together into a major section (block) of the course.

15b. Either of two bases can be used to set the examination schedule. If you want the exam schedules to be based on the natural groupings of the course content itself, type 1; if they are to be based on fixed time intervals, type 0.

16a. Next, decide on the frequency of examinations. You may choose as many as you wish of the examination frequencies listed by the computer (including all of them). If you want formal examinations to be given daily, type 1; otherwise, type 0. Use the same code for examinations given weekly, after each major course section (such as at midterm), and at the end of the course.

16b. Next, decide on the frequency of examinations. You may choose as many as you wish of the examination frequencies listed by the computer (including all of them). If you want to examine student progress after each topic, type 1; otherwise, type 0. Use the same code for examination after each major course section and at the end of the course.

17. Type the approximate number of minutes to be set aside for each kind of examination as it is displayed.

18. Examinations can test student mastery of only the material covered since the last examination or can test material covered in previous examinations. Although retention is encouraged by including materials from previous examinations, doing so can make the test too long or can force the examiner to slight the objectives that students should have attained since the previous examination.

19a. If the examination after each topic will test only that topic, type 1; if it will test that topic and some preceding topics in the same major section, type 2; if it will test that topic and some preceding topics in the course, type 3.

19b. If the examination after each major section will test only that section, type 1; if it will test that section and some preceding sections, type 2.

19c. If the end-of-course examination will test student mastery of only the last major section, type 1; if it will test student mastery of the entire course, type 2.

20a. If the examination after each day will test only that day's work, type 1; if it will test that day's work and some preceding work during the week, type 2; if it will test that day's work and some preceding work in the same major section, type 3; if it will test that day's work and some preceding course work, type 4.

20b. If the examination after each week will test only that week's work, type 1; if it will test that week's work and some preceding work in the same major section, type 2; if it will test that week's work and some preceding course work, type 3.

20c. If the examination at the end of a major section will test only that section, type 1; if it will test that section and previous sections, type 2.

20d. If the end-of-course examination will test student mastery of materials only in the last section, type 1; if it will test student mastery of the entire course, type 2.

21. Usually a proctor is provided during quizzes and exams to assure against obvious cheating. Designate the level of the proctor for each type of examination displayed by the computer by typing 1 for instructor; 2 for instructor's aide, student instructor, or clerk; 3 for student leader; or 0 for no proctor.

22. If many students will take the course, time and money can be saved by machine scoring of objective tests. Machine scoring also abets statistical analysis of test results, item analysis, and so forth. If only a few students will take the course, however, machine scoring can be overly expensive, even though it is assumed to take essentially no time. Consider primarily whether you need the additional data-processing capability when you make this decision.

If objective tests will be machine scored, type 1; otherwise, type 0.

23.* Perhaps you will want to allot scheduled time to the instructor (part of his work day) for scoring examinations. If so, the design program will allot 30 seconds per student for scoring per 60 minutes of objective examination (if not scored by machine) and 10 minutes per student per 60 minutes or examination calling for essay-type answers. For example, if an objective test for a class of 20 students takes 50 minutes, the instructor will be allowed 20 x ½ x 50/60 = 8½ minutes for scoring it. If an essay test for the same students takes 50 minutes, the instructor will be allowed 20 x 10 x 50/60 = 167 minutes (~ 2½ hours) for scoring it.

Alternatively, the instructor may do this chore after school. If you plan to allot part of the work day for scoring examinations, type 1; if not, type 0.

Planned Review

The computer directs you to these statements on the basis of your formal examination decisions. For example, if you decide to have an examination at the end of each topic and have answered questions 2 to 30, then you will be asked to read statement 31a.

30. Now review policy for Types I and II instruction must be established. Reviews may be carried out in scheduled lessons or unscheduled study and may

* Even if statement 22 is answered 1, statement 23 must be answered because some of the examinations may not be objective tests.

consist of simply going over basic instruction or of using material especially prepared for review. If it will be sufficient simply to suggest that students review the materials that will be subject to test, type 0, and the program will require no further decisions about review. If scheduled or unscheduled time will be allotted for review before each formal examination, type 1, and the program will skip statement 31. If time is to be allotted for reviews before only some of the examinations, type 2.

31a. If you want to allot time for review before the examination at the end of each topic, type 1; if not, type 0.

31b. If you want to allot time for review before the examination at the end of each day, type 1; if not, type 0.

31c. If you want to allot time for review before the examination at the end of each week, type 1; if not, type 0.

31d. If you want to allot time for review before the examination at the end of each major section, type 1; if not, type 0.

31e. If you want to allot time for review before the final examination, type 1; if not, type 0.

32. If the review will be conducted at a scheduled time and under the supervision of an instructor or monitor, type 1; if the student will do reviewing during unscheduled study, type 0.

33. If special materials will be prepared for this review, type 1; if not, type 0.

34. Type the number of minutes the average student will require to complete this review.

Scoring Deskwork

37. You decided that some basic instruction will require students to work with materials that record overt student responses but do not provide the answers.* Students can learn by scoring their own classroom work after completing it; however, this denies the instructor the opportunity of using the work to diagnose the daily progress of each student in detail. If you decide to use class time for students to score and discuss their work, scoring sessions will be included in any discussion sessions you schedule. This decision will apply to all cases of this kind in either Type I or Type II (classroom) instruction.

If students will score their classroom work in class, type 1; if not, type 0.

38a.† If many students will take the course and the instructor will receive information on each student's daily progress, a machine can be used to score classroom work calling for selected response. Machine scoring also abets statistical analysis of the reliability of individual items in programmed materials. As mentioned

* The computer will have directed you to this decision (statement 83) before it directs you here. Answers must be given to the student in an instructional strategy of self-pacing (the student must know whether he was right or wrong in order to pace himself), self-directed adaptivity or instructional method, response-pacing (the reaction of the machine gives feedback), or fully automated programs (CAI).

† Statement 38a will be read if the classroom instruction calls for selected responses and the answer to statement 22 was 0. (See statement 81 or the Glossary for a discussion of selected response.) If the answer to statement 22 was 1, the answer to statement 38a will be assumed to be 1.

Statement 38b will be read if the classroom instruction calls for constructed response.

earlier, however, if only a few students will take the course, machine scoring can be overly expensive. Finally, the choice of scoring classroom work can be left up to the instructor.

If a machine will be used to score classroom work, type 1; if part of the work day will be allotted to the instructor to hand-score classroom work, type 2; if scoring will be left to the instructor's discretion, type 0. If 2 is typed, the design program will allot 30 seconds per student for scoring per 60 minutes of basic instruction.

38b. The instructor may be allotted scheduled time (part of his work day) for scoring student classroom work. Alternatively, he may be expected to do this chore after school, at his discretion. If part of the work day will be allotted for scoring student work, type 1; if not, type 0. If you type 1, the design program will allot 10 minutes per student for scoring 60 minutes of basic instruction.

Question and Discussion Sessions

40. The choices you made to this point concerning presentation of material may result in relatively long sessions during which the student is learning essentially on his own. If the material is relatively simple, the most efficient tactic may be to let the student save whatever questions occur to him during the session for later discussion with his instructor (during a special discussion session) or his fellow students. This procedure is commonly used to review and discuss film presentations and the like. Alternatively, a monitor or full-fledged instructor may be on call during the initial presentation to answer questions as they arise. If the material is relatively complex, this may be the best choice.

If you want to allow time for a special discussion session with the instructor, type 1; if a monitor or an instructor will answer questions during the presentation, type 2; if the student can solve his problems by talking with fellow students on his own time, type 3.

41. If you expect to set formal instructional time aside for these special discussion sessions, type 1; if the sessions will be conducted outside of regular instructional hours, type 2.

42. Type the percentage of the time the student spends working on his own that should subsequently be devoted to discussion sessions.

43. Discussion sessions may be scheduled in several ways: they may be conducted at the same time every week, biweekly, or as often as necessary to take care of student needs. If discussion sessions are to be scheduled, the design program will schedule sessions at the same time each week or more often if necessary, based on a minimum length of 15 minutes per session.

Discussions may be conducted whenever 15 minutes worth of discussion time has accumulated, or they may be conducted immediately following difficult topics, if at least 15 minutes worth has accumulated.

If sessions will be scheduled at regular intervals, type 1; if they will be scheduled

whenever 15 minutes worth of discussion has accumulated,* type 2; if they will be given following difficult† topics, type 3.

44. If you want the instructor to be present for these discussions, type 1; if he may be at a distant location but accessible via a communication medium (such as in a studio for closed-circuit TV—students would have talk-back capability), type 0.

45. Several procedures may be used to enable an instructor or monitor to answer questions during a presentation. He may physically be present where the students are receiving the presentation or he may be at a distant location but accessible via a communication medium. In the latter case, accessibility may be continuous or it may be provided at preplanned points during the presentation.

If you want the instructor or monitor to be physically present for answering student questions during the presentation, type 1; if he may be at a distant location but accessible via a communication medium, type 0.

46. If accessibility should be continuous, type 1; if not, type 0.

TYPE I INSTRUCTION

Test Responses

47a. Objective tests, which call for selected responses, are generally difficult to write well, especially for diagnosing complex behavior. For example, it may require 45 minutes to write a good multiple-choice item. But objective tests are easy to administer and score, whereas tests calling for constructed responses take longer to administer, are often difficult to score objectively, and can require the grader to invest large amounts of time in reading and judging the students' work. Therefore, if the test will eventually be administered to many students, the time required to write an objective test may be well worth the investment. If only a few students will take the test before the course content is changed significantly, and if objectivity of scoring is not a serious problem, tests calling for constructed responses may be the better choice because they are easier to write.

47b. Because Type I instruction requires little drill or practice, it is almost always possible to examine student mastery using objective tests. Three options are open. If student mastery of all materials (easy or difficult) will be examined by tests calling for selected responses, type 1; if selected responses will be used only for relatively easy materials, type 2; if there are to be no questions calling for selected responses for formal examination, type 0.

48. Usually formal examinations are presented on printed pages, which may contain diagrams or pictures. In some cases, however, as in recognizing sounds or movement, it may not be possible to examine student mastery by means of the printed page. Such a case may require the same means of presentation as used in

* The design program will keep track of accumulated discussion time.

† As identified in the Curriculum Analysis.

the original basic instruction. If you want to use printed pages for review and examination of all of Type I instruction (substituting verbal descriptions or pictures where needed), type 1; if you want to use the same means you used in the original instruction for presenting examinations and reviews, type 0. If you type 0, and the instructor presented the learning event to be examined, the logical result would be for him to give the examination in person. (The Curriculum Analysis will have identified a media class appropriate for that learning event.) If a media system that could have been used for the learning event is obtained for other parts of the course, that media system will also be used for the examination.

If the presenter was an adaptive program or a response-paced program, a branching or response-paced test will be used.

Unscheduled Study (Homework)

50. Unscheduled study is defined as study by individual students or groups of students outside of normal class or lab periods and at times of their own choosing. This implies that no instructor or monitor is present, although special facilities may be needed such as libraries, learning centers, or study carrels. Students working individually with self-paced materials in a normal class period and under the scheduled supervision of a monitor are not engaged in unscheduled study. Unscheduled study levies no requirements on the instructional system for the scheduled presence of a trained or semitrained instructor nor for the scheduled use of facilities such as classrooms, workshops, or laboratories for the study of a specific body of material. These facilities may have to be made available, however, to meet student needs when they are not receiving regularly scheduled instruction.

If you will include unscheduled study in your course, type 1; if not, type 0.

51. Several means may be used to present information for unscheduled study. Students can work with books or workbooks or can view presentations by film, video tape, and the like. All media that can carry the full burden of information to be presented are termed communication media. Most such media normally present a given body of information within a fixed (invariant) period. We term anything that runs essentially without interruption and without changing pace or content a fixed-duration program. Presentation may also be accomplished by a response-paced program, a device that calls for overt student response, senses the response, and waits for the correct responses before proceeding with the presentation. An adaptive program not only accepts and acts on student responses but provides problems of varying levels of difficulty based on student responses.

If you want presentations of Type I instruction for unscheduled study to be by a communication medium, type 2; if by an adaptive program, type 4; if by a fixed-duration program, type 5; if by a response-paced program, type 7.

52. If you want stimuli for overt student response integrated into the presentation, type 1; if not, type 0.

53. If correct responses will be provided along with the presentation of stimuli, type 1; if not, type 0.

54. When a student is studying independently and without any particular time constraint, he can often make most efficient use of his time if he can spend more of it on sections that give him trouble, skip sections that are easy, or return to sections that he is not quite sure of. Without the addition of special devices, only the printed page provides this kind of freedom for self-direction, which we term internal random access. Controls such as fast forward can be added to fixed-duration programs, and other devices are being developed to make response-paced and adaptive programs flexible in this way. If you want the student to have internal random access for unscheduled study, type 1; if not, type 0.

55. You may want to use some means of checking whether the students have actually carried out their assignments for unscheduled study. Work may be collected and graded outside of class, which takes negligible time from scheduled instruction, some instructional time may be devoted to checking the work or giving a quiz, or the work may be discussed in class or with the individual student to clear up points of confusion. Probably the most effective tactic is to check the work or give a quiz, and then to discuss it with the students, but this is also the most time-consuming choice. Simply going over the work in class or with individual students without grading or otherwise checking it may encourage the lazy student to slight assignments because he believes he can rely on the discussion to learn the material. The most efficient strategy is to collect the work, grade it outside of scheduled instructional time, and discuss it in class or with individual students during the following scheduled session, but this puts the heaviest demands on the instructor.

If there will be checks, grades, discussions or quizzes on assignments for unscheduled study, type 1; if not, type 0.

56. If scheduled instructional time will be devoted to discussing or checking assignments for unscheduled study, type 1; if not, type 0.

57. How many scheduled minutes per session will be devoted to discussing or checking homework assignments, on the average?

Difficulty

59. In Type I instruction some topics are more difficult than others, depending on the students' familiarity with the material and their general ability to learn the given subject. At this point, if you designate two levels of difficulty for topics in Type I instruction, then two strategies can be set for Type I instruction—one for each level. In the Curriculum Analysis, topics are identified as easy or difficult. If a strategy will be set for only one difficulty level, type 1 for only one of the difficulty levels. If relatively easy topics will be taught, type 1; otherwise, type 0. Use the same code for relatively difficult topics.

TYPE I INSTRUCTION FOR RELATIVELY EASY AND RELATIVELY DIFFICULT TOPICS

This section contains two sets of decision points, each of which pertains to relatively easy or relatively difficult Type I instruction. For conciseness, the steps are presented in parallel. For example, statement 60a pertains to relatively easy material, and statement 60b pertains to relatively difficult material. While making decisions on relatively easy Type I instruction, the computer will direct you to statements pertaining to that category; similarly, for relatively difficult Type I instruction.

Specifying Strategies for Different Student Capabilities

You will be directed to this section only if you chose in the Statement of General Policy to specify different instructional strategies for different student learning capabilities for all or parts of the course. If not, you will proceed to statement 70 (variable pacing) or statement 77 (presentation).

60a. Specifying instructional strategies on relatively easy or simple topics for different student learning capabilities may involve little beyond deciding whether the brighter students can pick the information up from media and whether the slower ones may need help from the instructor.

If you want to adapt instruction of relatively easy topics to student learning capabilities, type 1; if not, type 0.

60b. In adapting instruction on relatively difficult topics to student learning capabilities, it may be necessary to establish sequences of related objectives or hierarchies of objectives. Each student's initial knowledge of points or steps in the sequence will probably be somewhat different from another's. Moreover, the sequence appropriate for one student may be different from that appropriate for another. It is likely that good decisions about such matters require a high degree of skill.

If instruction on relatively difficult topics will be adapted to student learning capabilities, type 1; if not, type 0.

61a.* Now the adapter of the instructional method must be chosen. Such adaptation may be made during instruction (concurrent) or between sessions of instruction (between-session) or both.

Instructor.

Considerations: For immature students, it is probably wisest to rely on the instructor to prepare in advance a daily or weekly set of study activities for each student. In some cases, however, curricula or adaptive programs have been designed that can assume this chore with minimal guidance from the instructor. If students are sufficiently mature, they may be able to design their own courses of study. The instructor may be the only agent competent enough to perform this task well,

* To be answered after statements 65 and 66.

however; this puts a heavy burden on him and may increase the system cost, and he may be impatient or unreliable (that is, he may react to student characteristics that are irrelevant to learning).

Logical Consequences: Choosing the instructor as the adapter does not limit your further decisions. That is, you may still choose the presenter of instruction and the way in which students will interact with the instruction. In effect, you may, by choosing the instructor as the adapter, design a system with both between-session *and* concurrent adaptivity.

Adaptive Program.

Considerations: Adaptive programs are expensive to prepare, although if many students will eventually use them, their cost may be spread thinly enough that they cost about the same as instructors. If appropriate adaptive programs are already available, the preparation cost may not be a stumbling block. Adaptive programs are usually presented by a computer, which further increases cost; however, adaptive programs may be prepared by highly qualified teachers within the subject area and can be more diverse in their adaptivity and more reliable than an average instructor. Furthermore, they never lose patience with the slow student nor are they threatened by the bright one.

Logical Consequences: An adaptive program manages the presentation of material. It will present stimuli for overt student response along with the presentation of information, "sense" students' responses for pacing and branching, and select the next set of objectives to be mastered. By the action of the machine, the student will automatically be given information about whether his responses are correct or incorrect. Because a machine manages the instruction, student responses must be selected.

61b.* **Student Leader.**

Considerations: Even though a high degree of competence is required to adapt teaching method to the needs of individual students, mature and responsible student leaders may be able to perform this task because they, in effect, speak the language of their peers. In addition, they are less expensive than instructors or adaptive programs. There may be peripheral benefits, as well, to using student leaders in this way. By teaching the subject matter, they may understand it better and retain it longer. They may also develop communication and other social skills and encourage the development of such skills by their peers. Finally, their own sense of responsibility toward and interest in learning may be improved.

Student leaders may, however, exhibit some of the same defects as an instructor, viz., unreliability (reaction to irrelevant student characteristics), impatience, fear of being shown up, or lack of imagination in accommodating to student differences.

Logical Consequences: It is unreasonable to expect a student leader to prepare the materials and aids he would need to adapt teaching method to student capabil-

* To be read only if course content must not be presented on a fixed schedule.

ity. Therefore, he must be provided with such materials. In addition, these materials should be programmed; that is, stimuli for overt student response must be integrated with the presentation so that the student leader can determine whether his efforts are successful. This also means that he will require models of correct responses in order to check student progress. (The students themselves may or may not be given these models during the instruction.) The student leader will be a concurrent adapter. Whether he is also a between-session adapter will depend on your answer to statement 62.

Individual Student.

Considerations: Assigning the role of adapter to each individual student presupposes that each has a relatively high degree of academic maturity. Although some students may have this maturity, it is unlikely that all of them do. In addition, making each student his own master does not encourage the development of social skills to the extent that use of student leaders does, although it may foster stronger attitudes of responsibility.

Logical Consequences: These are the same as for the choice of a student leader with one exception, viz., the students themselves must receive models of correct responses in order to direct their own progress.

61c. Adapting Type I instruction on relatively easy topics to student learning capabilities may simply require a decision about how much reliance to place on the instructor for presentation and explanation.

61d. Before Type I instruction on relatively difficult topics can be adapted to student learning capabilities, a careful analysis of the concepts or principles being taught may be required. Discovering how to perform this analysis and to tailor it to the needs of different learners may be very demanding. If instructors are skillful, you may expect them to perform these tasks. If not, well-made teaching materials may be needed. In more straightforward areas such as mathematics or reading, some adaptive programs have been worked out to accommodate differences in student learning abilities.

61e.* If you want the instructor to choose the materials and methods appropriate for each student or group of students, type 1; if an adaptive program, type 2; if each student, type 3; if a student leader, type 4.

61f.* If you want the instructor to choose the materials and methods appropriate for each student or group of students, type 1; if an adaptive program, type 2.

62. The instructor, the individual student, or the student leader may choose from among materials (media programs, reference books, lesson guides, etc.) prepared in units adapted to successive levels of difficulty to present the subject matter and to provide knowledge of student progress. Such stratified materials may be more carefully tailored to anticipated student needs, but they are more expensive than a general presentation. Students who are relatively more adept at independent study can make better use of a general presentation than less independent students.

If you want to provide stratified materials for source materials, type 2; if a general presentation will suffice, type 1.

* Will be read if a fixed schedule has not been chosen.

Grouping

This section is entered only if within-class grouping is used for the pertinent category of instruction such as relatively easy Type I instruction. Statement 65 must be answered if tracking is *not* used (tracking puts students into invariant groups for all types of instruction). Statement 66 then reminds the user of the ability level of the students that his immediate decisions pertain to. The user then returns to statement 61.

65a. For instruction on relatively easy or simple topics, how would you like your students grouped? (Refer to your analysis of student population to be performed in step 1 of MODIA.) If into two categories (slow and average-to-bright), type 1; if into three categories (slow, average, and bright), type 2; if into two categories (bright and slow-to-average), type 3; if each student is treated on an individual basis, type 4.

65b. For instruction in relatively difficult or complex topics, how would you like to group students? (Refer to your analysis of student population.) If into two categories (slow and average-to-bright), type 1; if into three categories (slow, average, and bright), type 2; if into two categories (bright and slow-to-average), type 3; if each student will be treated on an individual basis, type 4.

66a. Now determine instructional strategy for the slow group. Next you will determine it for the average-to-bright group before proceeding to the next type of instruction.

66b. Now determine instructional strategy for the slow group. Next you will determine it for the bright group, and finally for the average group, before proceeding to the next type of instruction.

66c. Now determine instructional strategy for the bright group. Next you will determine it for the slow-to-average group before proceeding to the next type of instruction.

66d. Now determine strategy that allows the instruction to be tailored to individual needs. Immature students may require considerable help from the instructor; more mature students may work quite independently.

66e. Now determine instructional strategy for the bright group. Next you will determine it for the average group before proceeding to the next type of instruction.

66f. Now determine instructional strategy for the average group before proceeding to the next type of instruction.

66g. Now determine instructional strategy for the slow-to-average group before proceeding to the next type of instruction.

66h. Now determine instructional strategy for the average-to-bright group before proceeding to the next type of instruction.

Variable Pacing

The computer will direct you to this section if you chose variable pacing for all or parts of the course. If you did not choose it for *all* of the course, you first decide

whether it will be used in the part of the course to which your current decisions pertain (statement 70).

70a. Some educators believe that there is a greater spread in student ability to learn difficult subjects than in their ability to master easy or simple subjects. If you hold this view, you might find variable pacing more useful for relatively difficult Type I instruction. Variable pacing typically requires more time in preparing materials (such as programmed texts), but if many students will use the materials, this investment may readily be repaid. Variable pacing may also be accomplished by tutoring individual students or by constructing different activities for small groups of students. This may be justified when highly personalized instruction is needed, such as teaching a performing artist or dealing with a student who has severe educational or emotional handicaps.

70b. If you want to use variable pacing for relatively easy Type I instruction, type 1; if not, type 0.

70c. If you want to use variable pacing for relatively difficult Type I instruction, type 1; if not, type 0.

71a. Next, you must choose the controller to pace the instruction. Some of the considerations surrounding and logical consequences of the various choices are discussed below.

Individual Student.

Considerations: Assigning the individual student as pacer builds study skills, frees the fast learner to direct his attention to particularly difficult or interesting topics, and allows the slow learner to take his time without fear of embarrassment. If students are immature or insufficiently motivated, however, they may take advantage of the situation to dally.

Logical Consequences: If the individual student controls pacing, he must be supplied with programmed materials, and these must provide him with the correct responses to enable him to pace himself. He will, of course, progress at his own rate, not at the average rate of a group.

Instructor.

Considerations: An instructor can speed up the learning of students whose motivations are deficient and can immediately spot points at which students are having difficulty. Instructors are expensive, however, especially when used as tutors or leaders of very small groups of students, and some instructors may become impatient with slow learners.

Logical Consequences: If the instructor controls pacing, he must also present the basic instruction.

Student Leader of a Small Group.

Considerations: Assigning a student leader as pacer builds study skills, communication skills, and other social skills. It may also promote longer retention of the material learned, at least by the student leader, and overcome the effects of poor motivation among the other students. Student leaders are less expensive pacers

than instructors and have some of the same desirable attributes. They may also be more patient with and understanding of their peers. Mature students who are interested in the instruction should be chosen as student leaders.

Logical Consequences: A student leader must be supplied with programmed materials to work from, and these materials must provide him with the correct responses so that he will know how to pace the group. (He does not have to transmit the correct responses to the group, however.)

Response-Paced Program.

Considerations: Response-paced programs (usually presented by teaching machines) are the most objective and reliable of all pacers. They cannot become impatient, and will not proceed until the student has made the correct response. The student cannot skip idly through the program but must interact with it frame by frame. A response-paced program cannot entirely overcome the effects of poor motivation, however, because the student can still dally in answering or can answer at random until he hits the right response. The hardware cost for presenting response-paced programs is usually not a dominant consideration.

A linear programmed text is not a response-paced program because the student controls his own pace when working with a programmed text. Programmed texts can call for either selected* or constructed responses.

Logical Consequences: If a response-paced program is the pacer, the instruction must be presented by whatever communication medium is appropriate. Student responses must be selected in nature because practical machines have not yet been built that can recognize and determine the correctness of natural language or other types of constructed responses. It is assumed that the machine's reaction to the student's response provides him with sufficient feedback about the correctness or incorrectness of his response.

71b. If the leader of a small group will pace the presentation of information for relatively easy Type I instruction, type 1; if the individual student, type 2; if the instructor, type 3; if a response-paced program, type 4.

71c. If the leader of a small group will pace the presentation of information for relatively difficult Type I instruction, type 1; if the individual student, type 2; if the instructor, type 3; if a response-paced program, type 4.

72. Pacing may be regulated on the basis of some average rate of response.† If students can be grouped relatively homogeneously, such an approach can approximate the benefits of individual pacing and decrease expense by requiring less preparation or fewer instructors. If such groups will be formed, type 1; if not, type 0.

73. Select the number of levels of student learning rate to be accommodated by homogeneous grouping by typing 2, 3, or 4.

74. It is often helpful to give an instructor who is controlling the pace of learning a programmed guide, supplemented by instructional aids as necessary, that discusses the basic content to be learned and contains the stimuli for student re-

* See the discussion of selected response in statement 81.

† Response rate is correlated with learning capability.

sponse. If you would like the instructor to have a programmed guide, type 1; if not, type 0.

Presentation

The following set of statements is read for a particular category of instruction only if instructional strategy will not be tailored to student learning capabilities and there is no variable pacing, or if an instructor will tailor instructional strategy to student learning capabilities. In all other instances, the presentational means and other matters will have already been determined.

77a. Several means may be used to present information. An instructor or a student leader, supplied with needed reference materials, texts, and instructional aids, can address one or more students, answering questions as they arise or when the presentation ends. Alternatively, students can work individually with books or workbooks, or can view presentations by film, television, and the like. We term all media that can carry the full burden of the information to be presented communication media. That is, a communication medium makes it possible to present a message without the message sender (teacher or curriculum designer) being present at the point of reception by the learner.

Most communication media normally present a given body of information within a fixed (invariant) period. Films, television programs, and audio tapes are examples. Anything that runs essentially without interruption and without changing pace or content in response to outside influences is termed a fixed-duration program. Telemedia programs are usually of fixed duration.

Fixed-duration programs simplify scheduling. They do not, however, allow an individual student to go back over material or to select material at random (as he can with books, workbooks, and the like) unless they are recorded media such as film or tape, and are being used in the individual mode, with the necessary equipment so he can control the presentation as he wishes.

For relatively easy Type I instruction, a student leader could present information as could any appropriate communication medium. Usually when a student acts as an instructor, he will learn more than he would otherwise. You might prefer to save the best instructors for presenting information for relatively difficult Type I instruction. If you choose any appropriate communication medium, the final choice of media system will be made on the basis of your design criteria.

77b. If you want the instructor to present information for relatively easy Type I instruction, type 1; if any appropriate communication medium, type 2; if a student leader, type 3; if a fixed-duration program, type 5.

77c. If you want the instructor to present information for relatively difficult Type I instruction, type 1; if any appropriate communication medium, type 2; if a student leader, type 3; if a fixed-duration program, type 5.

77d.* Because a fixed schedule must be maintained, it is probably unwise to allow a student leader to present information, although individual students can

* Will be read if a fixed schedule has been chosen.

work with communication media under the instructor's supervision. Therefore, presentations should be made by an instructor, by fixed-duration programs, or by any appropriate communication media.

77e. If you want an instructor to present information in person for relatively easy Type I instruction, type 1; if students will work with appropriate communication media, type 2; if fixed-duration programs will be used, type 5.

77f. If you want an instructor to present information in person for relatively difficult Type I instruction, type 1; if students will work with appropriate communication media, type 2; if fixed-duration programs will be used, type 5.

78a. You chose an instructor to present information. If the instructor is highly skilled and has extensive teaching experience, it may be wisest to allow him considerable latitude in choosing materials and instructional aids for his presentation. Alternatively, trained curriculum designers, producers of educational materials, designers of training aids, and so on, may be available to prepare the materials and aids that the instructor may draw from. If you want to supply the instructor with prepared materials and aids, type 1; if the instructor must gather or generate his own materials and aids, type 0.

78b. Even though you may want the instructor to gather or generate his own materials, in some situations it may be relatively expensive or even overly dangerous for him to do so. This may be especially true if special equipment or facilities are needed to present the instruction—for example, if the effects of nuclear weapons are to be demonstrated. In such cases, it may be necessary or more practical to use an appropriate communication medium to present the message.

If you want to use a communication medium for presentations requiring special facilities or equipment, type 1; if not, type 0.

79a. Frequently, several relatively simple tasks are taught at once, such as the names of parts of a piece of equipment. In that case, stimuli for overt student response may profitably be integrated into the presentation of information to enhance student learning. If you want such stimuli integrated into the presentation for relatively easy Type I instruction, type 1; if not, type 0.

79b. Relatively difficult instruction often requires the student to spend some time absorbing many different interrelated items of information. An example is the development of an understanding of how a particular combat strategy is related to the tactics required to carry it out.

Whether or not the use of integrated stimuli for overt student response during the presentation will enhance or hinder learning will depend largely on the skill of the writer, producer, or presenter of self-contained programs. If you want such stimuli integrated into the presentation for relatively difficult Type I instruction, type 1; if not, type 0.

80. There are several arguments in favor of recording student responses even when the responses are not to be used for formal examination of student progress. The student can use recorded responses for self-evaluation or the responses can be used in class to provide a springboard for classroom discussion. The instructor can use the responses to diagnose student strengths and weaknesses so that subsequent

instruction (or even the course materials) can be tailored more precisely to student needs.

In many instances, student responses are inevitably recorded when they are made. Some examples are handwritten or typed responses or student-created products. In other instances, responses may be ephemeral. For example, response-paced programs often register a response only long enough for the machine to react (or fail to react) to it. Spoken responses are the most common in classroom work and are rarely recorded.

The decision at this point concerns only those responses that would not automatically be recorded anyway. If such responses will be permanently recorded for later study by students or instructors, type 1; if not, type 0.

81a. Many instructional system designers prefer that student responses be selected (that is, of the multiple-choice, true-false, or matching variety) rather than constructed, because such responses are more easily checked and checking can be more objective; however, it is very time-consuming to write good questions that require selected response. For complex materials, such as those in which students must combine several interrelated skills to solve a problem, comprehensive diagnosis of student learning by items calling for selected response will make major demands on the skills of the item writers.

This time may be well spent if many students are involved, however, because the checking of constructed responses can be time-consuming.

81b. Student progress in relatively easy Type I instruction can often be checked quite satisfactorily by eliciting selected responses. Constructed responses requiring the student to speak, write, draw, or otherwise produce something, can provide richer information concerning the student's level of understanding or mastery. Sometimes, as in the teaching of spoken language, they are required. If you would prefer to elicit selected responses during relatively easy Type I instruction, type 0; if constructed responses, type 1.

81c. You may be less willing to use selected responses to check on student mastery of relatively difficult tasks because most selected responses do not reveal how a student arrived at his selection. Clever writers, however, can reduce the possibility of a student choosing the right selection via the wrong route and can provide diagnostic information also. If you would prefer to elicit selected responses during relatively difficult Type I instruction, type 0; if constructed responses, type 1.

83. The student can receive the correct response or an example of an adequate response to each stimulus as part of the presentation after he has had time to respond. In this way, he receives immediate knowledge of his progress. Integrating answers or models with the presentation of stimuli incurs little additional cost in terms of writing or presenting the material. However, waiting until all the students are finished and then giving the answers and scoring the work together can provide a valuable springboard for class discussion. Students who finish early can go on to other work while they wait for the others.

If correct responses or models are to be provided along with the presentation of stimuli, type 1; if not, type 0.

84.* Since you did not choose an instructor to present the instruction, it is possible to give someone responsibility for monitoring the class. A significant saving can result if the monitor is not an instructor.

If you want an instructor as a monitor, type 1; if an instructor's aide, a clerk, or a student instructor will be sufficient, type 2; if a student leader, type 3; if no monitor, type 0.

Policy Change

86. You will now be asked to set instructional policy for relatively difficult Type I instruction, such as the teaching of concepts and principles. Depending on your philosophy of instruction, you may be more or less willing for the materials to be presented by a communication medium than you were for the relatively simple instruction. Also, you may be less willing to use selected response as a means for testing student mastery of the materials. If you want to alter the instructional policy you set for relatively easy Type I instruction with regard to relatively difficult Type I instruction, type 1; if not, type 0.

TYPE II INSTRUCTION

Individual or Interactive Skills

90. You are now ready to set policy for Type II instruction, which requires appreciable drill or practice but does not require that students work with special equipment or in a special location. Much Type II instruction deals with cognitive skills such as arithmetic, written composition, spelling, and problem solving. Type II instruction also deals with psychomotor skills such as pronunciation of foreign words or penmanship, or social skills such as public speaking or the ability to contribute in small group discussions.

We first classify Type II instruction on the basis of the way a class or group of students will be organized when the drill or practice is under way. Generally, the students will work individually; for example by practicing addition, writing sentences, drawing graphs, or responding to questions.† Often, however, group participation will be required, such as in panel discussions, committee work, or dramatic presentations. A recent technique is to teach or reinforce skills by means of game playing. (Games requiring only minimal equipment such as paper and pencil, dice, or counters are included in Type II instruction.) Included in the category of interactive skills are those requiring the individual to address a group; public speaking or formal debate would also come under this category.

* Will be read if an instructor was not chosen as presenter.

† Even when groups of students are responding orally in unison, they are not engaged in developing interactive skills. Rather, each student is developing a skill he will practice as an individual.

Considering the course you are designing, what kinds of Type II instructional activities will be included? If individual performance will be used, type 1; if not, type 0. Use the same code if game playing or other activities requiring groups of students to work together will be used or if an individual will have to address a group.

TYPE II INSTRUCTION—INDIVIDUAL DRILL OR PRACTICE

Complexity

100. We classify Type II instruction by means of individual performance as relatively simple and relatively complex, depending on whether sessions of fairly routine, repetitious, or automatic drill are needed, or whether several interrelated skills need to be developed. Simple Type II instruction can include memorizing foreign words, learning multiplication tables, reading numerical tables, plotting points on a graph, or practicing the formation of letters. Note, however, that these may not be simple skills for some students, who may have to learn several skills at once in order to master them. In addition, a skill such as learning to multiply numbers of several digits together may initially be relatively complex but may become relatively simple as students develop proficiency. Therefore, determining whether a skill is simple or complex depends on the level of prior student achievement as much as it does on the skill itself. Your choices for simple Type II instructional strategy may be similar to those you made for simple Type I instruction because they will be based on your assessment of student ability and achievement as well as on instructor proficiency.

Complex skills include such activities as solving word problems in arithmetic, writing a paragraph, showing relationships by means of a rough sketch, or composing a speech. The development of complex skills may require close supervision during the initial phases of practice, because the student cannot know whether he is proceeding in the right direction until he completes the work.

If the course you are designing will include relatively simple Type II instruction, type 1; otherwise, type 0. Use the same code for relatively complex instruction.

TYPE II INSTRUCTION—INDIVIDUAL PERFORMANCE

This section contains two sets of decision points for individual performance—relatively simple or relatively complex. For conciseness, the sets are presented in parallel as in statement 110.

Scheduling of Performance Sessions

110a. First you must determine a strategy for relatively simple individual performance. Often, exercises are assigned for unscheduled study rather than being scheduled for a preassigned time for classroom work or supervised work at a computer terminal or audiovisual device. If all simple exercises are to be performed in unscheduled study, type 0; if some or all simple exercises will be performed in regularly scheduled sessions, type 1.

110b. Now you must determine a strategy for relatively complex individual performance. Work on solving complicated problems, writing essays, and so on, is often assigned as homework or for special projects, rather than being scheduled for classroom work or supervised work at a computer terminal or TV display. If all complex exercises are to be performed in unscheduled study, type 0; if some or all complex exercises will be performed in regularly scheduled sessions, type 1.

111a.* Since you chose to conduct some or all simple exercises at regularly scheduled times and under supervision, you will be asked to set instructional policy first for the supervised sessions. Then you will decide how skills should be demonstrated to the students. Finally, you will set policy for assignment of simple exercises for unscheduled study.

111b. Since all simple exercises will be carried out in unscheduled study, you will first be asked to set policy for demonstrating the skills to the students. Then you will decide how to assign simple exercises.

112a.† Since you chose to have students practice some complex skills in regularly scheduled sessions and under supervision, you will be asked to set instructional policy first for the supervised sessions. Then you will decide how the skills should be demonstrated to the students. Finally, you will set policy for assigning complex problems for unscheduled study.

112b. Since all complex performance will be carried out without supervision, you will first be asked to set policy for demonstrating skills to the students. Then you will decide how to make the assignments of problems for unscheduled study.

Performance Model

113. An initial learning event that demonstrates a skill each student should master can motivate and direct the students by providing them with a model and goals for performance.‡ Carefully developed, step-by-step discussion can be very effective in this regard. The selection of means for demonstrating skills to students will hinge on questions of both practicality and effectiveness. If many students will

* The computer will direct you to statement 111a or 111b depending on which choice you made in statement 110a.

† The computer directs the user to statements 112a or 112b depending on the choice made in statement 110b.

‡ Note that a performance model as used here is different from the demonstration (presentation) of an idea or concept in Type I instruction. The intent is to distinguish between presentations that students will eventually copy and those that they will not.

eventually observe the demonstrations, it may be well to make widely available the work of an instructor who is highly competent not only in the skills to be mastered but also in explaining the steps required for mastery. In addition, if small or partially hidden movements are involved, such as those required for pronunciation, a communication medium can make these more visible to more students than can an instructor in person. A well-written text can be used as well as film or other recorded media. If the material will need frequent revision, video tape of modularized text could be most practical. Recorded demonstrations can also be studied independently or at a time of the student's own choosing.

If only a few students will observe the demonstrations and if the average instructor is sufficiently competent in explaining what is to be learned, it may be best to rely on instructors to present whatever models are needed. In addition, during a demonstration in person by an instructor, the students can ask for clarification of points they do not understand.

Finally, a good student can often demonstrate the skill to his classmates with minimal prior preparation (such as step-by-step directions). Use of students to teach other students reinforces learning and can encourage a spirit of cooperation and interest.

In this section we assume that a model of performance involves no learner(s) performance of the skill. A follow-me demonstration, in which students copy step-by-step procedures, can be used to introduce students to techniques for solving complex problems. We put follow-me demonstrations in a separate category of instruction. Thus, they will be treated as introductory practice sessions in teaching complex skills, not as pure models of performance.

113a. If there will be an initial demonstration of a skill, it may be more practical to use the same means of presentation as that used for the performance session so that the transition will be least disruptive.

113b. In setting policy for simple individual performance with constructed response, you chose to present stimuli by the means the computer has just typed out.* If you would like to change your policy for demonstrating this performance, type 1; if not, type 0.

113c. In setting your policy for complex individual performance with constructed response, you chose to present problems by the means the computer has just typed out.* If you would like to change your policy for demonstrating the performance, type 1; if not type 0.

113d. In setting policy for relatively easy Type I instruction, you chose to present information by the means the computer just typed out. If you would like to change this policy for presenting models of relatively simple performance, type 1; if not, type 0.

113e. In setting policy for relatively difficult Type I instruction, you chose to present information by the means the computer just typed out. If you would like to change this policy for presenting models of relatively complex performance, type 1; if not type 0.

* You will have been directed to make these choices (statements 161 or 191) by the computer before you reach this point.

114. Even though scheduled sessions are not planned for simple performance,* you may want to schedule presentations of models of the skills to be mastered. This would be particularly true if an instructor will make the demonstrations. If demonstrations of simple performance are to be scheduled, type 1; if not, type 0.

115a. If an instructor will demonstrate a simple performance in person, type 1; if a communication medium, type 2; if a student leader, type 3; if a fixed-duration program, type 5. If you did not type 1, any policy established for discussion sessions for basic instruction will be applied to discussion sessions for demonstrations. If you type 1, you will need to indicate the maximum size of the viewing group in the Curriculum Analysis.

115b. If an instructor will demonstrate a complex performance in person, type 1; if a communication medium, type 2; if a student leader, type 3; if a fixed-duration program, type 5. If you did not type 1, any policy established for discussion sessions for basic instruction will be applied to discussion sessions for demonstrations. If you type 1, you will need to indicate the maximum size of the viewing group in the Curriculum Analysis.

115c.† If you want any appropriate communication medium to present unscheduled demonstrations of simple performance, type 2; if a fixed-duration program, type 5.

116. If you will provide the instructor with a guide for making his demonstration, type 1; if not, type 0.

Follow-Me Demonstrations or Step-by-Step Directions for Complex Performance

120. Follow-me demonstrations or step-by-step directions can be used to introduce students to techniques for solving complex problems and are treated as introductory practice sessions in teaching complex performance. Because follow-me demonstrations combine presentation and student performance, they will require a separate set of decisions. Therefore, if these are included, the strategies you established for simple performance will not apply because they do not require follow-me demonstrations or step-by-step directions.

If follow-me demonstrations or step-by-step directions are included in your course, type 1; if not, type 0.

121. Even though sessions for complex performance are not scheduled during regular class hours,‡ you may wish to give follow-me demonstrations or step-by-step directions during scheduled instruction so that all students will receive essentially the same initial directions and guidance. If follow-me demonstrations or step-by-step directions during scheduled instruction are planned, type 1; if they will be given for homework, type 0.

* Decided in statement 110a.

† Will be read if answer to statement 114 is 0.

‡ Decided in statement 110b.

122a. You should now choose the presenter for any follow-me demonstrations or step-by-step directions you may schedule. In general, logistic considerations may dictate that follow-me demonstrations and initial directions for the performance that succeeds them should be presented by the same means. There may be situations, however, in which the means should be different—for example, when the follow-me demonstrations should be presented by a knowledgeable person but a student leader may present initial practice directions, or when the students perform in unscheduled study but receive scheduled follow-me demonstrations or step-by-step directions. An advantage to a fixed-duration program is that it can be used to assure that all students take the same amount of time in observing the demonstrations and will thus all begin the performance portion simultaneously.

After you choose the presenter for follow-me demonstrations, specify strategy for presenting initial directions for complex performance.

If you want an instructor to present follow-me demonstrations, type 1; if any appropriate communication medium, type 2; if a student leader, type 3; if a fixed-duration program, type 5.

122b. Now choose the presenter for any follow-me demonstrations or step-by-step directions you wish to provide for unscheduled study. Again, logistic considerations may dictate that follow-me demonstrations and initial directions for the performance that succeeds them directly should be presented by the same means.

After the presenter for follow-me demonstrations is chosen, return to decisions about presentation of directions and stimuli for complex performance.

If you want an appropriate communication medium to present follow-me demonstrations, type 2; if a fixed-duration program, type 5.

123.* If you will provide the instructor with a lesson guide for making his follow-me demonstration or for giving step-by-step directions, type 1; if not, type 0.

Unscheduled Study

124a. Earlier you indicated that some simple student performance would be scheduled. If you also wish to assign simple performance for unscheduled study, type 1; if not, type 0.

124b. Earlier you indicated that some complex student performance would be scheduled. If you also wish to assign complex performance for unscheduled study, type 1; if not, type 0.

125a.† For unscheduled simple performance, the presentation of stimuli that call for selected responses may be made by any appropriate communication medium, or it may be made by a special type of presentation/response system, specifically: a fixed-duration program, a response-paced program, or an adaptive program. Each has its advantages and disadvantages.

* To be read only if answer to statement 122 is instructor.

† The part of statement 125 that will be read will depend not only on whether simple or complex instruction is being considered, but also on whether this performance may be checked by selected response or by constructed response.

If you select any appropriate communication medium, the final choice of a specific medium will be based on considerations of appropriateness and your design criteria.

A fixed-duration program has the advantage of forcing the student to respond at a preset rate. This may be desirable for developing speed of response.

The adaptive program not only accepts and acts on student responses, but also provides problems of varying levels of difficulty based on student responses. Because the adaptive program includes branching of various types, it is the most expensive to prepare and administer; it can take several times as long to write as a nonadaptive program.

If you want an adaptive program to present stimuli for simple performance, type 4; if a fixed-duration program, type 5; if a response-paced program, type 7; if any appropriate communication medium, type 2.

125b. For unscheduled simple performance, the presentation of stimuli that may *not* be answered by selected responses may be made by any appropriate communication medium or may require a fixed-duration program. If you select any appropriate communication medium, the final choice of a specific medium will be based primarily on considerations of appropriateness and your design criteria. A fixed-duration program has the advantage of forcing the student to respond at a preset rate. This may be desirable for developing speed of response.

If you want a fixed-duration program to present stimuli for simple performance, type 5; if any appropriate communication medium, type 2.

125c. For unscheduled complex performance that may be checked by selected response, the presentation of directions and stimuli may be made by any appropriate communication medium, a response-paced program, or an adaptive program. (Because the development of speed of response is probably not an objective in this type of instruction, the fixed-duration program is excluded from these choices.) Again, each of these has its advantages and disadvantages.

If you select any appropriate communication medium, the final design choice of a specific medium will be based primarily on considerations of appropriateness and your design criteria.

A response-paced program accommodates the rate of presentation to student response and provides automatic knowledge to the student about whether his response was correct or incorrect.

An adaptive program not only accepts and acts on student responses but also branches to problems of varying levels of difficulty based on student responses. Such a program, however, is the most expensive to prepare and administer.

If you want an adaptive program to present directions and problems for complex performance, type 4; if a response-paced program, type 7; if any appropriate communication medium, type 2.

125d. For unscheduled complex performance that may *not* be checked by selected response, the presentation of directions and problems cannot be made by automated programs. Hence, only an appropriate communication medium can be used, and you have no decision to make.

126a. It is a relatively simple matter to supply the student with the correct answers to his exercises, especially when they call for selected responses. Answers allow the student to check his own progress in unscheduled study and may help him redirect his efforts until he discovers how to find the right solution. Providing answers, however, may make it harder to find out whether the student has actually done the work. Quizzes, classroom questions, and the like may then be needed.

If you want to supply the answers along with the problems assigned for unscheduled study, type 1; if not, type 0.

126b. When exercises call for constructed student responses, it may be difficult to integrate the presentation of any correct answer with the presentation of the problems themselves. This is especially true for complex problem-solving requiring creation of new materials, such as in essay writing.

If you want to supply models of acceptable answers along with the problems assigned for unscheduled study, type 1; if not, type 0.

127a. Unscheduled performance sessions can be made much more effective as teaching techniques if the student can record his responses and have his performance evaluated either by himself, the instructor, or his peers. Some Type II instruction may call for special equipment beyond the traditional paper and pencil for recording student responses. For example, practicing pronunciation can be more effective if a record is made on audio tape; practicing a speech may be recorded on video tape.

127b. If you would like to provide whatever equipment is needed to record a student's response in unscheduled simple performance, type 1; if not, type 0.

127c. If you would like to provide whatever equipment is needed to record a student's unscheduled complex performance, type 1; if not, type 0.

Test Responses

In the Curriculum Analysis you designated which skills require constructed student responses and which may make use of selected student responses for informal diagnosis of student progress during ongoing instruction. You will now decide to what extent these designations should apply in formal examinations.

130a. It may or may not be possible to examine student mastery of simple skills by means of objective tests. Skills that require psychomotor responses, such as pronouncing words or forming letters, cannot be examined in this way.

If it will be possible to examine student mastery of *all* simple skills taught in your course by objective tests and if you would like to do so, type 1. If student mastery of simple skills that you designated for constructed responses during instruction should also be examined by tests calling for constructed responses, type 2.

130b. It may not be possible to examine student mastery of complex skills by objective tests. Skills that require psychomotor responses, such as public speaking, for example, cannot be examined in this way.

If it will be possible to examine student mastery of *all* complex skills taught in your course by objective tests and if you would like to do so, type 1. If student

mastery of those complex skills designated for constructed responses during instruction should be examined by tests calling for constructed responses, type 2.

131a. *You may have decided against selected responses to check student progress in mastering simple skills because such responses do not permit full diagnosis.* It is still possible that examinations could be objective, if they will not be used as diagnostic instruments.

If objective tests would be useful to examine student mastery of simple skills in your course, type 1; if not, type 0.

131b. You may have decided against selected responses to check student progress in mastering complex skills because such responses do not permit full diagnosis.* It is still possilbe that examinations could be objective, if they will not be used as diagnostic instruments.

If objective tests would be useful to examine student mastery of complex skills, type 1; if not, type 0.

Grouping

You will be directed to this section only if in the Statement of General Policy you chose to specify different strategies of instruction for different student learning capabilities.

135. To adapt instruction to student capabilities, you may place students in the following groups: slow and average-to-bright; slow, average, and bright; slow-to-average and bright. Alternatively, you may tailor instruction to each individual student.

135a. In setting strategy for relatively easy Type I instruction, you chose to group your students into the types the computer just printed out. If you want to change this strategy for relatively simple Type II instruction, type 1; if not, type 0.

135b. In setting strategy for relatively difficult Type I instruction, you chose to group your students into the types the computer just printed out. If you want to change this strategy for relatively complex Type II instruction, type 1; if not, type 0.

135c. To adapt relatively simple Type II instruction to student capabilities, you may place your students into several types of groups or treat them individually. If two capability levels will be used, slow and average-to-bright, type 1; if three, slow, average, and bright, type 2; if two, slow-to-average and bright, type 3; if students will be treated individually, type 4.

135d. To adapt relatively complex Type II instruction to student capabilities, you may place your students into several types of groups or treat them individually. If two capability levels will be used, slow and average-to-bright, type 1; if three, slow, average, and bright, type 2; if two, slow-to-average and bright, type 3; if students will be treated individually, type 4.

* The computer will have directed you to statement 140, where this decision is made, before you read statement 131.

Variable Pacing

The computer will direct you to this section if you chose variable pacing for all or parts of the course. If you did not choose it for *all* of the course, you must decide whether to use it in the part of the course to which your current decisions pertain (statement 137).

137a. During the initial phases of a simple exercise, it may be well to adjust the presentation of stimuli to the student's individual learning rate, unless the skills to be learned are very simple. As the student's response becomes more automatic with repeated drill, however, and if speed of response is to be developed, you may wish to shift to fixed pacing later in the session. If speed of response is not an objective, however, or if the students are highly motivated to master the materials as quickly as possible, it may be most efficient to use variable pacing throughout all simple exercises.

If variable pacing is desired throughout simple performance sessions, type 1; if only during the initial phases of the sessions, type 2; if not at all, type 0.

137b. For relatively difficult Type I instruction, you chose the policy the computer just typed out with regard to variable pacing. If you want to change this policy for relatively complex performance, type 1; if not, type 0.

137c. If you want to use variable pacing for relatively complex performance, type 1; if not, type 0.

Type of Response

140a. Although student progress in Type I instruction can almost always be checked by having the student respond selectively to questions, student progress in Type II instruction frequently cannot be checked in this way. Any instruction involving psychomotor skills such as speaking, writing, or drawing requires constructed responses. There is a tradeoff between the number of students who will work with the material and the time required to write the questions requiring selected response.

140b. If constructed responses will be used for diagnosing student progress in mastering simple skills, type 1; if not, type 0. Use the same coding for selected responses. If you are unsure, type 1 for both.*

140c. It is very difficult to diagnose a student's progress comprehensively in mastering complex skills by means of selected response. If the student fails to choose the right final answer, there is no way of determining at what point in the process his work was faulty. In some cases, such as essay writing, no right answers exist. Thus, selected responses may not be useful for assisting the instructor or the student, particularly during early learning phases.

If you will want to use constructed responses for diagnosing student progress in mastering complex skills, type 1; if not, type 0. Use the same coding for selected responses. If unsure, type 1 for both.*

* At this point the computer gives you the opportunity to choose either selected or constructed responses or both.

TYPE II INSTRUCTION—SIMPLE INDIVIDUAL PERFORMANCE

This section contains two sets of decision points pertaining to simple Type II instruction for individual performance—a category requiring constructed responses and a category requiring selected responses. For conciseness, the sets are presented in parallel as in statement 145.

145a. Now you will decide how to conduct supervised sessions of simple performance involving *constructed* student responses.

145b. Now you will decide how to conduct supervised sessions of simple performance involving *selected* student responses.

146.* You are now going to determine strategy for relatively simple Type II instruction that will permit selected student responses. The use of selected responses adds the possibility that they may be scored objectively, quickly, and even automatically, and that automated programs may be used. If you want to change the policy you just set in order to add automated scoring or for any other reason, type 1; if not, type 0.

Adapting Instruction to Student Capabilities

You will be directed to this section only if you chose in the Statement of General Policy to specify different instructional strategies for different student learning capabilities for all or parts of the course. If not, you will be directed to statement 155 (controller of pacing) or statement 160 (presentation).

150. Adapting instruction in simple skills to student capabilities may involve little beyond deciding whether or not sets of exercises at several levels of difficulty will be needed. Then the instructor, a student leader, or even an individual student may choose the appropriate materials. Read the considerations about the logical consequences of choosing an instructor, student leader, or individual student for this role, discussed in statements 61a and 61b.

150a. Much recent work with computer-assisted instruction has centered on developing programs that will adapt the instruction to the student's prior knowledge and learning style. Read the considerations about the logical consequences of choosing an adaptive program for this role, discussed in statement 61a.

151a. For relatively easy Type I instruction, you selected the means the computer just designated to adapt instruction to meet student needs in the groups chosen and to present information to them. If you want drill sessions with constructed responses to be handled by a different means, type 1; if not, type 0.

151b. For relatively easy Type I instruction, you selected the means the computer just designated to adapt instruction to meet student needs in the groups chosen and to present information to them. If you want drill sessions with selected response to be handled by a different means, type 1; if not, type 0.

* This statement is read instead of statement 145b if strategy is already determined for simple instruction with constructed response.

152a.* If you want the instructor to adapt the instruction for relatively simple performance, type 1; if each student, type 3; if a student leader, type 4.

152b.† If you want the instructor to adapt the instruction for relatively simple performance, type 1; if an adaptive program, type 2; if each student, type 3; if a student leader, type 4.

152c.† Because you chose to have all students master the course objectives on a fixed schedule, it would be unwise to allow a student leader or an individual student to choose instructional method. He might not be able to budget his time well enough to keep up with the rest of the class. Read the considerations about the logical consequences of choosing an instructor or an adaptive program for this role, discussed in statement 61a.

If you want the instructor to adapt the instruction, type 1; if an adaptive program, type 2.

152d.* Because you chose to have all students master the course objectives on a fixed schedule, it would be unwise to allow a student leader or an individual student to choose instructional method. He might not be able to budget his time well enough to keep up with the rest of the class. Hence, an instructor must adapt the instruction.

Controller of Pacing

The computer will direct the user to this section if he chose to use variable pacing for simple Type II instruction in individual skills.

155a. Now you must choose who will control the pacing of the presentation of stimuli. Since the pacer may also be the presenter, and presenting stimuli for relatively simple performance may be boring to the instructor, students could act as drill masters. Read the considerations surrounding and logical consequences of choosing the instructor, the student leader, or the individual student as pacer, discussed in statement 71a.

155b. For relatively easy Type I instruction, you chose to have the information paced to fit student learning rates by the means designated by the computer. If you wish to pace the presentation of stimuli for simple performance with constructed response in the same way, type 0; if not, type 1.

155c. For relatively easy Type I instruction, you chose to have the information paced to fit student learning rates by the means designated by the computer. If you wish to pace the presentation of stimuli for simple performance with selected response in the same way, type 0; if not, type 1.

155d. When selected responses are used, it is also possible to choose a response-paced program to control pacing. Stimuli are presented via a communication medium and the program senses student responses. Read the considerations surrounding and logical consequences of choosing a response-paced program as pacer, discussed in statement 71a.

* Read for constructed response.

† Read for selected response.

155e.* If the leader of a small group should regulate pacing, type 1; if the individual student, type 2; if the instructor, type 3.

155f.† If the leader of a small group should regulate pacing, type 1; if the individual student, type 2; if the instructor, type 3; if a response-paced program, type 4.

Presentation

The following set of statements will be read for presentation of instruction in two cases: (1) if instructional strategy will not be tailored to student learning capabilities and there is no variable pacing, or (2) if an instructor is to tailor instructional strategy to student learning capabilities. In all other instances, the presentational means and other matters will have already been determined.

160a. Presenting stimuli for simple skills can become boring for an instructor. A student leader can provide this function, or the individual student can work from a communication medium. A special case is a fixed-duration program; these can be useful if a minimum rate of student response to stimuli is to be developed.

160b. The computer has typed out the means you chose for presenting information in relatively easy Type I instruction. If you wish to use the same means for presenting stimuli for simple performance with constructed response, type 0; if not, type 1.

160c. The computer has typed out the means you chose for presenting information in relatively easy Type I instruction. If you wish to use the same means for presenting stimuli for simple performance with selected response, type 0; if not, type 1.

160d. If you will use an instructor to present directions and stimuli, type 1; if any appropriate communication medium, type 2; if a student leader, type 3; if a fixed-duration program, type 5.

160e. With selected responses usable, you may also choose a response-paced program to present stimuli. Such a program adjusts the presentation rate by stopping after each question and waiting for correct student response before proceeding, which may be desirable in drill exercises.

If you will use an instructor to present directions and stimuli, type 1; if any appropriate communication medium will suffice, type 2; if a student leader, type 3; if a fixed-duration program, type 5; if a response-paced program, type 7.

161a. Because students must master the basic course materials on a fixed schedule, it is probably best for the instructor to oversee student performance. Because presenting stimuli for simple performance can become boring for an instructor, you may prefer that he supervise student work with communication media. A special case is a fixed-duration program; these can be useful if a minimum rate of student response to drill stimuli is to be developed.

* Read for constructed response.

† Read for selected response.

161b. If you want the instructor to present directions and stimuli, type 1; if any appropriate communication medium, type 2; if a fixed-duration program, type 5.

161c. Because student mastery of simple skills may be diagnosed by selected responses, it is also possible to use a response-paced program to present stimuli. Such a program may be particularly useful for slow students because it automatically provides them with knowledge of their progress and can be more effective in retaining their attention.

If you want the instructor to present directions and stimuli, type 1; if any appropriate communication medium, type 2; if a fixed-duration program, type 5; if a response-paced program, type 7.

162. Unless student responses are being used to evaluate the student's mastery of a skill or to diagnose his strengths and weaknesses, the student may receive the correct response to each stimulus as part of the presentation after he has had time to respond. In this way, he learns immediately of his progress. Integrating the responses with the presentation of stimuli incurs little additional cost in terms of writing or presenting the material. Although it can encourage the student to have a greater sense of responsibility for his own learning, waiting to score responses until all the students are finished can provide a valuable springboard for class discussion.

If the correct responses will be provided along with the presentation of stimuli, type 1; if not, type 0.

TYPE II INSTRUCTION—COMPLEX INDIVIDUAL PERFORMANCE

Policy Change

170. You will now set instructional policy for relatively complex Type II instruction, such as teaching problem solving. Depending on your instructional philosophy, you may be less willing for a communication medium to present the stimuli than you were for relatively simple performance. Your choices for adaptivity, variable pacing, and the like may also be different if you anticipate a wider range in student abilities at higher levels of learning. In addition, complex Type II instruction may not lend itself as readily as simple Type II instruction to evaluation by means of selected student responses.

Keeping these points in mind, review the learning events in the Curriculum Analysis that were singled out for Type II instruction. Then, if the instructional strategy set for relatively simple Type II instruction will be altered with regard to relatively complex Type II instruction, type 1; if not, type 0.

Setting Strategy

This section contains two sets of decision points pertaining to complex Type II instruction for individual performance—a category requiring constructed responses

and a category requiring selected responses. For conciseness, the sets are presented in parallel as in statement 175.

175a. Now determine an instructional policy concerning how to conduct scheduled sessions of complex performance involving constructed student responses.

175b. Now determine an instructional policy concerning how to conduct scheduled sessions of complex performance involving selected student responses.

176.* Now set policy for relatively complex Type II instruction that will permit selected student responses. The use of selected responses adds the possibility that they may be scored objectively, quickly, and even automatically, and that automated programs may be used. If you want to change the policy you just set in order to add automated scoring or for any other reason, type 1; if not, type 0.

Adapting Instruction to Student Capabilities

You will be directed to this section only if you chose to specify different instructional strategies for different student learning capabilities for all or parts of the course in your Statement of General Policy. If not, you will proceed to statement 185 (controller of pacing) or statement 190 (presentation).

180. Adapting instruction in complex skills to student capabilities may involve establishing a sequence of related objectives or a hierarchy of objectives. Each student's initial skills required for steps in the sequence will probably be somewhat different. Moreover, the sequence appropriate for one student may be different from that appropriate for another. It is likely that good decisions about such matters will require a high degree of instructional skill. Read the considerations surrounding and logical consequences of choosing an instructor, student leader, or individual student for this role as discussed in statements 61a and 61b.

180a. In some highly structured subject areas, such as mathematics or physics, some adaptive programs have been worked out to accommodate differences in student learning abilities and are generally available. Read the considerations surrounding and logical consequences of choosing an adaptive program for this role as discussed in statement 61a.

181a. For relatively difficult Type I instruction, you selected the means the computer just designated to adapt instruction to meet needs of individual students in the groups shown and to present information to them. If you want performance of complex skills with constructed response to be handled by a different means, type 1; if not, type 0.

181b. For relatively difficult Type I instruction, you selected the means the computer just designated to adapt instruction to meet needs of individual students in the groups shown and to present information to them. If you want performance of complex skills with selected response to be handled by a different means, type 1; if not, type 0.

* This statement is read instead of statement 175b if strategy is already determined for complex instruction with constructed response.

182a.* If the instructor will adapt the instruction for performance of relatively complex skills, type 1; if the student, type 3; if a student leader, type 4.

182b.† If the instructor will adapt the instruction for performance of relatively complex skills, type 1; if an adaptive program, type 2; if the student, type 3; if a student leader, type 4.

182c.† Because you chose to have all students master the course objectives on a fixed schedule in the Statement of General Policy, it would be unwise to allow a student to choose instructional method. He might not be able to budget his time well enough to keep up with the rest of the class.

If the instructor will adapt the instruction, type 1; if an adaptive program, type 2.

182d.* Because you chose to have all students master the course objectives on a fixed schedule in the Statement of General Policy, it would be unwise to allow a student to choose instructional method. He might not be able to budget his time well enough to keep up with the rest of the class. Hence, an instructor must adapt the instruction.

Controller of Pacing

The computer will direct you to this section if you chose variable pacing for complex Type II instruction in individual skills.

185a. Now choose the controller of pacing stimuli for performing complex skills. Read the considerations surrounding and logical consequences of choosing the instructor, the student leader, or the individual student as discussed in statement 71a.

185b. For relatively difficult Type I instruction, you chose to have the presentation of information paced to fit student learning rates by the means just designated by the computer. If you wish to use the same means for presenting directions and suggestions for the performance of complex skills with constructed response in the same way, type 0; if not, type 1.

185c. For relatively difficult Type I instruction, you chose to have the presentation of information paced to fit student learning rates by the means just designated by the computer. If you wish to use the same means for presenting stimuli and directions for performance of complex skills with selected response, type 0; if not, type 1.

185d. When selected responses are used, it is also possible to choose a response-paced program to control pacing. A communication medium presents stimuli, and student responses are entered into and evaluated by the program. Read the considerations surrounding and logical consequences of choosing a response-paced program as pacer as discussed in statement 71a.

* Read for constructed response

† Read for selected response.

Presentation

190a. The presentation of directions and stimuli for performing complex skills is probably the least demanding part of this kind of instruction. Performance models and follow-me demonstrations of such skills require the most knowledge on the part of the presenter.

190b. The computer has typed out the means you chose for presenting information in relatively difficult Type I instruction. If you wish to use the same means for presenting stimuli and directions for performing complex skills with constructed response, type 0; if not, type 1.

190c. The computer has typed out the means you chose for presenting information in relatively difficult Type I instruction. If you wish to use the same means for presenting directions and stimuli for performing complex skills with selected response, type 0; if not, type 1.

191. Since students must master the basic course materials on a fixed schedule, it is probably best for the instructor to oversee student performance of complex skills. However, presentation of stimuli and directions does not necessarily require the instructor's attention, and you may prefer that he supervise the students while they work with communication media. If the instructor will present directions and stimuli, type 1; if any appropriate communication medium, type 2.

192. Unless student responses are being used to evaluate the student's mastery of a skill or to diagnose his strengths and weaknesses in highly structured subjects such as arithmetic or engineering, the student can receive the correct answer to each problem after he has had time to work it himself. In this way, he learns something about his progress; and even though the answer does not provide diagnostic information, he may be able to find his errors by working backwards.

In other areas, however, such as written composition, creative photography, and the like, there is no right answer for a particular assignment. But the student can be supplied with models of accepted practice to compare with his own work.

Integrating the responses in highly structured subjects by presenting stimuli incurs little additional cost in terms of writing or presenting the material. In unstructured areas, however, it may require production or reproduction of complex products such as diagrams and the like. In either case, encouraging the student to judge his own work can heighten his perceptions, increase his sense of responsibility for his own progress, and develop self-instructional skills.

In highly structured areas, delays may be introduced by waiting to score responses until all the students are finished in order to provide a springboard for class discussion. In addition, teaching students to work backwards from answers may be a poor tactic if skills of synthesis, rather than analysis, are being taught.

If responses or models are provided along with the presentation of stimuli, type 1; if not, type 0.

193. There are several arguments in favor of recording student responses even when the responses will not be used for formal examination of student progress. Recorded responses can be used by the student for self-evaluation or they can be used in class to provide a springboard for class discussion. The instructor can use them

to diagnose student strengths and weaknesses so that subsequent instruction (or even the course materials) can be more precisely tailored to student needs.

Recording of constructed responses can be time consuming and expensive, however, particularly if special recording equipment such as video-tape machines is required.

If student responses will be permanently recorded for possible later evaluation by students or instructors, type 1; if not, type 0.

Appendix C

PROGRAM OUTPUT FOR BASIC STILL PHOTOGRAPHY COURSE

This appendix contains an example of the DISTAF program output, a specific strategy of instruction. It also presents the record of the interaction between the user and the computer as the user established the strategy.

The DISTAF output, *A Strategy for Teaching a Course in Basic Still Photography* is a shortened and revised version of an actual course given to airmen in the Technical School at Lowry Air Force Base. It was chosen because the Air Force Plan of Instruction provided a detailed statement of the curriculum for the course and because the course contained a fairly wide range of different kinds of teaching situations from classroom presentation and discussion to exercise of students' photographic skills in the darkroom and out of doors. Each type of instruction offered a wealth of material for the application of novel teaching techniques.

The strategy was devised with the idea that the course would be presented at an Air Force Technical School and would produce about 2500 graduates annually. The nominal course length is two weeks, and the average student load is 100. An instructional system that could be used to teach the course using the stated strategy has been designed and costed. This system is described in detail in R-1021-PR.*

The DISTAF output that follows is largely self-explanatory. Note that, in general, strategy decisions are grouped by category of instruction. The exception is that the leader for follow-me demonstrations is displayed along with decisions for student performance because of the similarity of these two categories. Sometimes student performance can be checked by calling for selected responses even though the student is actually making constructed responses as he performs. The choice of the leader for follow-me demonstrations of such skills appears along with the choice of whoever gives directions or problems for solution because quite logically they may be the same agency.

Note also that there is no output for the strategy for Type III instruction, since that part of the program has not been completed.

* Petruschell and Carpenter, op. cit.

In the *Record of Computer-User Interaction,* all of the phrases and directions shown have been typed out by the computer except for the numbers following equal signs (=), which the user types in. The reader may find it useful to follow this interaction with the help of the User's Manual, Appendix B.

A STRATEGY FOR TEACHING A COURSE IN BASIC STILL PHOTOGRAPHY

```
ENTIRE COURSE
Students will not take co. se work other than basic work.
Instructional strategies won't be tailored to the students' capabilities.
There will be no remedial sessions.
Students will master the course on a variable schedule.
Variable pacing will be used throughout the course.
Added rewards will not be used to provide motivation.
The following types of instruction will be used:
 Type 1 instruction
 Type 2 instruction
 Type 3 instruction


ALL OF TYPES 1 AND 2 INSTRUCTION
Tests will be conducted on the following schedule
 After each topic
 At the end of the course
Test information:
 For each topic quiz
  The test length is  15 minutes.
  No proctor will be needed.
  The content covered will be
   only the topic just completed.
  No time will be allocated for review.
Test information:
 For the final examination
  The test length is 360 minutes.
  No proctor will be needed.
  The content covered will be
   the entire course.
  The student will review at a scheduled time under supervision.
  Special materials will be prepared for this review.
  This review will take the average student 120 minutes to complete.
Part of the working day will be used to grade formal examinations.
Formal examinations by means of objective tests
 will be machine scored.

The student can discuss material presented by communication media
 in a special session with the instructor.
Discussions will be scheduled during regular class hours.
 10 percent of the presentation time will be used for discussion sessions.
Discussion sessions will occur when 15 min. of discussion have accumulated.
```

FOR ALL TYPE 1 INSTRUCTION
All formal examinations will be objective tests.
Reviews and formal examinations will be presented by
the same means as the original instruction.
Students will not have homework.

FOR RELATIVELY EASY TYPE 1 INSTRUCTION
Pacing will be controlled by
a response-paced program.
Each student will proceed at his own rate.
Presentation is by
a response-paced program.
No monitor will be necessary.
Stimuli for overt student response
are integrated into the presentation.
Student responses are permanently recorded.
Selected responses are required.
The student will be given the correct response.

FOR RELATIVELY DIFFICULT TYPE 1 INSTRUCTION
Pacing will be controlled by
the individual student.
Each student will proceed at his own rate.
Presentation is by
any appropriate communication medium.
No monitor will be necessary.
Stimuli for overt student response
are integrated into the presentation.
Student responses are permanently recorded.
Selected responses are required.
The student will be given the correct response.

ALL OF TYPE 2 INSTRUCTION

Individual practice or drill will be used.
Relatively complex instruction will be used.

TYPE 2 COMPLEX INSTRUCTION

Examination of student mastery of skills designated for constructed
response will call for constructed responses.
Reviews and formal examinations will be presented by
the same means as the original instruction.
Students will not have homework.
Models of student performance will be presented by
a live instructor.
The instructor will be provided a guide for demonstrating performance.
Follow-me demonstrations will be used in the course.
Follow-me demonstrations will be scheduled during regular class hours.

TYPE 2 COMPLEX INSTRUCTION
WITH CONSTRUCTED RESPONSE

Follow-me demonstrations will be presented by
 a live instructor.
The instructor will be provided a guide for follow-me demonstrations.
Pacing will be controlled by
 an instructor.
Each student will proceed at his own rate.
A programmed guide will not be supplied.
Presentation is by
 a live instructor.
Materials will be supplied for the instructor.
Stimuli for overt student response
 are integrated into the presentation.
Student responses are permanently recorded.
Constructed responses are required.
The student will be given the correct response.

TYPE 2 COMPLEX INSTRUCTION
 WITH SELECTED RESPONSE

Follow-me demonstrations will be presented by
 a live instructor.
The instructor will be provided a guide for follow-me demonstrations.
Pacing will be controlled by
 the individual student.
Each student will proceed at his own rate.
Presentation is by
 any communication medium.
No monitor will be necessary.
Stimuli for overt student response
 are integrated into the presentation.
Student responses are permanently recorded.
Selected responses are required.
The student will be given the correct response.

RECORD OF COMPUTER-USER INTERACTION

This section of the questioning pertains to the questionnaire
 which you filled out prior to beginning this session.
 Please type '1' for yes answers and '0' for no answers.
Question 2 = 1
Question 5 = 0
Question 8 = 0
Question 14 = 0

The headings will remind you of the category of instruction
 to which the current decisions pertain.

ENTIRE COURSE

Please read statement 8.
Variable pacing = 1
Please read statement 9 b.
Added rewards = 0
Please read statement 11.

```
Type 1 = 1
Type 2 = 1
Type 3 = 1

ALL OF TYPES 1 AND 2 INSTRUCTION

Please read statement  15.
Please read statement  15 a.
Please read statement  16 b.
Test after
Topic = 1
Major section = 0
Course = 1

For topic quiz
Please read statement  17.
Test length(minutes) = 15
Please read statement  18.
Please read statement  19 a.
Content tested = 1
Please read statement  21.
Proctor = 0

For final exam
Please read statement  17.
Test length(minutes) = 360
Please read statement  18.
Please read statement  19 c.
Content tested = 2
Please read statement  21.
Proctor = 0
Please read statement  22.
Machine scored = 1
Please read statement  23.
Scheduled scoring = 1

Please read statement  30.
Planned review = 2

Please read statement  31 a.
For topic quiz
Allocate time for review = 0

Please read statement  31 e.
For final exam
Allocate time for review = 1
Please read statement  32.
Scheduled = 1
Please read statement  33.
Prepare special materials = 1
Please read statement  34.
Minutes = 120

ALL OF TYPE 1 INSTRUCTION

Please read statement  59.
Easy = 1
Difficult = 1
```

```
SCHEDULED EASY TYPE 1
Please read statements  71 a and b.
Pacer = 4
Please read statement  80.
Recorded response = 1
Please read statement  84.
Level of monitor = 0
Please read statement  72.
Grouping = 0

ALL OF SCHEDULED TYPES 1 AND 2

Please read statement  40.
Discussion opportunity = 1
Please read statement  41.
Scheduled discussions = 1
Please read statement  42.
Percent = 10
Please read statement  43.
Type of discussion schedule = 2

SCHEDULED DIFFICULT TYPE 1

Please read statement  86.
Policy change for difficult Type 1 instruction = 1
Please read statements  71 a and c.
Pacer = 2
Please read statement  80.
Recorded response = 1
Please read statements  81 a and c.
Constructed response = 0

Please read statement  83.
Answers given = 1
Please read statement  84.
Level of monitor = 0

ALL OF TYPE 1 INSTRUCTION

Please read statements  47 a and b.
Test with selected response = 1
Please read statement  48.
Printed tests = 0

ALL OF UNSCHEDULED TYPE 1 INSTRUCTION

Please read statement  50.
Homework = 0

ALL OF TYPE 2 INSTRUCTION

Please read statement  90.
Individual = 1
Group = 0
```

ALL OF TYPE 2 INSTRUCTION, INDIVIDUAL PERFORMANCE

Please read statement 100.
Simple = 0
Complex = 1

TYPE 2 INSTRUCTION,COMPLEX INDIVIDUAL PERFORMANCE

Please read statement 120.
Follow-me = 1
Please read statement 110 b.
Scheduled exercises = 1
Please read statement 112 a.
Please read statements 140 a and c.
Constructed response = 1
Selected response = 1

SCHEDULED TYPE 2, COMPLEX PERFORMANCE
WITH CONSTRUCTED RESPONSE

Please read statement 175 a.
Please read statements 185 a and b.
The presentation of difficult Type 1 instruction was paced by
the individual student.
Policy change for exercises with constructed response = 1
Please read statement 155 e.
Pacer = 3
Please read statement 72.
Grouping = 0
Please read statement 74.
Programmed guide = 0

Please read statement 78 a.
Background materials = 1
Please read statement 192.
Answers given = 1
Please read statement 193.
Recorded response = 1
Please read statement 122 a.
Demonstrator(follow-me) = 1
Please read statement 123 b.
Guide for follow-me demonstrations = 1

SCHEDULED TYPE 2, COMPLEX PERFORMANCE
WITH SELECTED RESPONSE

Please read statement 176.
Policy change for exercises with selected response = 1
Please read statements 185 a, c, and d.
The presentation of difficult Type 1 instruction was paced by
the individual student.
Policy change = 0
Please read statement 122 a.
Demonstrator(follow-me) = 1
Please read statement 123 b.
Guide for follow-me demonstrations = 1

ALL TYPE 2, COMPLEX PERFORMANCE

Please read statement 113.
Please read statements 113 a and c.
The presenter for complex individual performance w/ constructed response:
 a live instructor.
Policy change for demonstrations = 0
Please read statement 116.
Guide for pure demonstrations = 1
Please read statement 124 b.
Unscheduled exercises = 0
Please read statement 130 b.
Test with selected response = 2
Please read statement 48.
Printed tests = 0

Appendix D

LIST OF VARIABLES IN NUMERICAL ORDER

Variable	Value	Meaning	Manual Statement No.
		For course in general	
A(1)	1	Tailor strategies for parts of course.	3
	2	...entire course.	
	3	...none of the course.	
A(2)	1	Entire course variably paced.	8
	2	Some types of instruction variably paced.	
	0	None of course variably paced.	
		For Types I and II instruction	
A(4)	1	Natural subject matter groupings being used for evaluation.	15b
	0	Fixed-time schedule...	
		For Type I instruction	
A(5)	1	Type I difficult instruction now being processed.	Automatically set
	0	Type I simple...	
		For appropriate subcategory of instruction	
__(6)	1	Presenter is instructor.	77a & c
	2	...any appropriate communication medium.	(or 77a, d, & f)
	3*	...student leader.	(or 77a & b)
	4*	...adaptive program.	(or 190a & 160e)
	5	...fixed-duration program.	(or 190a & 191)
	7*	...response-paced program.	(or 160a & d)
			(or 160a & 161a & b)
			(or 190a & 160d)

*4 available only if method adaptive; 7 available only if variable pacing; 3 available only if variable schedule.

Variable	Value	Meaning	Manual Statement No.
__(7)	1	Stimuli for overt response integrated with scheduled basic instruction.	79b
	0	Stimuli not integrated...	
__(8)	1	Responses permanently recorded.	80
	0	Responses not recorded.	(or 193)
__(9)	1	Constructed responses required.	81a & c
	0	Selected responses permitted.	(or 81a & b)
		For Types I and II instruction	
A(10)	1	Selected responses made during classroom work are machine scored.	38a
	2	Part of the work day used to score class work.	
	0	Scoring of class work up to instructor.	
A(11)	1	Allot scheduled or unscheduled time to review each evaluation.	30
	2	...some evaluations.	
	0	Students review on their own.	
A(12)	P	Percentage of presentation time set aside for discussion sessions.	42
		For appropriate subcategory of instruction	
__(13)	1	Variable pacing used.	70a & c
	0	...not used.	(or 70a & b)
			(or 137a)
__(14)	1	Pacer is student leader.	71a & c
	2	...individual student.	(or 71a & b)
	3	...instructor.	(185a & d & 155f)
	4	...response-paced program.	(155a & e)
__(15)	1	Students grouped by learning rate.	72
	0	Each student proceeds at own rate.	
__(16)	1	Programmed guide supplied.	74
	0	...not supplied.	
		For Types I and II instruction	
A(17)	1	Student can discuss material presented by a communication medium in a special session with an instructor.	40
	2	...during the presentation with a monitor or instructor.	
	3	No special arrangements made to discuss presentations by communication media.	
		For all relatively complex Type II instruction	
H(17)	1	Follow-me demonstrations given.	120
	0	...not given.	
		For Types I and II instruction	
A(18)	1	Discussions scheduled during regular class hours.	41
	2	...outside of regular class hours.	

Variable	Value	Meaning	Manual Statement No.
		For relatively complex Type II instruction	
H(18)	1	Follow-me demonstrations scheduled.	121
	0	...unscheduled.	
__(19)	1	Instructor presents follow-me demonstrations.	122a or 122b
	2	Any appropriate communication medium...	
	3	A student leader...	
	5	A fixed-duration program... (1 and 3 not available if demonstrations unscheduled).	
		For Types I and II instruction	
A(20)	1	Instructor or monitor must be physically present during presentation by a communication medium.	45
	0	...does not have to be physically present.	
		For appropriate subcategory of instruction	
__(21)	1	Background materials and instructional aids supplied.	62 or 78a
	2	Stratified background materials and instructional aids supplied.	
	0	Instructor expected to obtain or prepare his own materials.	
		For Types I and II instruction	
A(22)	1	Instructor or monitor must be accessible continuously during presentation by a communication medium.	46
	0	...does not have to be accessible continuously.	
		For appropriate type of instruction	
__(23)	1	All formal examinations by objective tests.	47b (or 130a or 131a)
	2	Formal examinations by objective tests for only relatively easy instruction.	
	0	No formal examinations by objective tests.	
__(24)	1	Students have homework assignments.	50
	0	...no homework assignments.	
		For course in general	
A(28)	1	When variable pacing is being used, rewards will include additional free time.	10
	0	Rewards will not include...	
		For appropriate subcategory of instruction	
__(29)	1	Acceptable response presented after student has had time to respond.	83 (or 192)
	0	Acceptable response not presented...	(or 162)

Variable	Value	Meaning	Manual Statement No.
		For course in general	
A(30)	1	Course content adapted to student background.	Input from general policy
	0	Course content not adapted...	
A(37)	1	Tracking used to facilitate adapting method to student capabilities.	Input from general policy
	0	Other means used.	
		For appropriate subcategory of instruction	
__(39)	1	Stimuli for overt response integrated with assignments for unscheduled study.	52
	0	Stimuli not integrated...	
		For Type II instruction	
A(41)	1	Type II difficult instruction is now being processed.	Automatically set
	0	Type II simple instruction...	
__(45)	2	Assignments for unscheduled study by any appropriate communication medium.	51 (or 125c)
	4	...an adaptive program.	(or 126b)
	5	...a fixed-duration program.	
	7	...a response-paced program.	
__(46)	1	Acceptable responses provided.	53 (or 126a)
	0	Answers not provided.	(or 126b)
__(47)	1	Student responses in unscheduled study recorded.	127a & c (or 127a & b)
__(48)	1	Student will be able to "study" the material (have internal random access).	54
	0	...will not have internal random access.	
		For appropriate subcategory of Type II instruction	
__(50)	1	Models of student performance presented by instructor.	113 & 115b 115a or c
	2	...a communication medium.	
	3	...a student leader.	
	5	...a fixed-duration program.	
		Types I and II instruction	
A(51)	1	Instructor will have part of his workday for scoring formal examinations.	23
	0	...will grade papers on his own time.	
		For course in general	
A(53)	1	Students expected to master course content on fixed schedule.	Input from general policy
	0	...on variable schedule.	

Variable	Value	Meaning	Manual Statement No.
		For course in general or for appropriate subcategory of instruction	
__(54)	1	To facilitate adaptivity of method, students divided into two groups--slow and average-to-bright.	65b (or 65a)
	2	...into three groups--slow, average, and bright.	
	3	...into two groups--slow-to-average, and bright.	
	4	Each student treated on an individual basis (no tracking).	
		For appropriate type of instruction	
__(55)	1	Reviews and examinations presented by printed materials.	48
	0	...by same means as original instruction.	
		For Types I and II instruction	
A(56)	1	Instructor must be physically present for discussion sessions.	44
	0	...does not have to be physically present.	
A(57)	1	Objective tests machine scored.	22
	0	...not machine scored.	
A(58)	1	Students score their work in class.	37
	0	...do not score their work in class.	
A(59)	1	Instructor has part of his workday for scoring constructed responses made during classroom work.	38b
	0	...must score this on his own time.	
A(60)	1	Indicates the bright loop of the grouping section is being processed.	Automatically set
	3	...the average loop (including slow-to-average, average-to-bright, or if no grouping, the individual).	
	0	...the slow loop.	
		For Type I instruction of the appropriate level of difficulty	
__(61)	1	Any appropriate communication medium used to make presentations requiring special facilities or equipment.	78b
	0	...not used	
		For relatively complex Type II instruction	
H(62)	1	The instructor or student leader given a guide for making follow-me demonstrations.	123
	0	...not given guide.	
		For appropriate subcategory of instruction	
__(63)	1	Teaching method adapted by an instructor.	61a, b, d, & e
	2	...an adaptive program.	(or 61a, b, c, & e)
	3	...the individual student.	(or 61a, d, & f)
	4	...a student leader (3 and 4 not allowed if fixed schedule).	(or 180 & 182c) (or 180 & 180a & 182b)

Variable	Value	Meaning	Manual Statement No. (or 150 & 152a) (or 152d) (or 180 & 182d)
		For course in general	
A(64)	1	Remedial sessions scheduled.	6
	2	...assigned for unscheduled study.	
		For appropriate type of instruction	
__(72)	1	Homework checked.	55
	0	Homework not checked.	
__(73)	M	Average number of minutes spent in class checking or discussing an assignment for unscheduled study.	57
		For course in general	
A(76)	1	Students categorized on the basis of prior information on their background.	2
	2	...evaluation of work after an initial period of time.	
	3	...a diagnostic pretest.	
		For Types I and II instruction	
A(77)	1	Discussion sessions held at regular intervals.	43
	2	...whenever 15 minutes of discussion have accumulated.	
	3	...following difficult topics.	
		For appropriate subcategory of instruction	
__(78)	1	The monitor is an instructor.	84
	2	...an instructor's aide, clerk, or student instructor.	
	3	...a student leader.	
	0	No monitor necessary.	
__(80)	N	Number of levels to be grouped by student learning rate.	73
		For the appropriate type of instruction	
__(85)	1	Scheduled class time will be devoted to checking or discussing homework assignments.	56
	0	...will not be devoted...	
		For course in general	
A(95)	1	Remedial work provided.	5
	2	Students not allowed to repeat sections.	
	3	Both of the above used.	
A(96)	P	Percentage of time required for basic instruction required for additional scheduled remedial sessions.	7a

Variable	Value	Meaning	Manual Statement No.
A(97)	1	Instructor conducts scheduled remedial sessions.	7a
	0	Remedial sessions conducted in same manner as basic instruction.	
e(1,i)	1	A formal evaluation given after each topic (i=1). ...each major section (i=2). ...the end of the course (i=3).	16b
	0	...will not be given.	
e(2,i)	1	A formal examination given after each day's work (i=1). ...each week's work (i=2). ...each major section (i=3). ...the end of the course (i=4).	16a
	0	...not given.	
e(3,1)	1	Quiz at the end of a topic covers only that topic.	19a
	2	...that topic and others in the same major section.	
	3	...that topic and all preceding lessons.	
e(3,2)	1	The examination at the end of a major section covers that section only.	19b
	2	...that section and all preceding sections.	
e(3,3)	1	The final examination covers the last major section of the course only.	19c
	2	...the entire course.	
e(4,1)	1	The daily quiz covers that day's work only.	20a
	2	...that day's work and all preceding in the week.	
	3	...that day's work and all preceding in the same major section.	
	4	...that day's work and all preceding in the course.	
e(4,2)	1	The weekly quiz covers the week's work only.	20a
	2	...the week's work and all work in the same major section.	
	3	...the week's work and all preceding work.	
e(4,3)	1	The examination on a major section covers that section only.	20c
	2	...that section and all preceding sections.	
e(4,4)	1	The final examination covers the last major section of the course only.	20d
	2	...the entire course.	
e(5,i)	1	Type I instruction (i=1), Type II instruction (i=2), Type III instruction (i=3) used.	11
	0	...not used.	
e(6,i)	1	Relatively easy (i=1), relatively difficult (i=2) Type II instruction used.	59
	0	...not used.	

Variable	Value	Meaning	Manual Statement No.
		For Type II instruction	
e(7,i)	1	Individual skills (i=1), team skills (i=2) taught.	90
	0	...not taught.	
		For Type II instruction, individual skills	
e(8,i)	1	Simple skills (i=1), complex skills (i=2) taught.	100
	0	...not taught.	
		For simple Type II instruction, individual skills	
e(9,i)	1	Selected responses (i=1), constructed responses (i=2) may be used to check student mastery of some skills.	140a
	0	...cannot be used...	
		For complex Type II instruction, individual skills	
e(10,i)	1	Selected responses (i=1), constructed responses (i=2) may be used to check student mastery of some skills.	140b
	0	...cannot be used...	
		For Types I and II instruction	
e(11,i)	1	A review planned for each daily quiz (i=1), each weekly quiz (i=2), each major section examination (i=3), the final examination (i=4).	31b 31c 31d 31e
	0	...not planned...	
e(12,i)	1	Scheduled review planned before each daily quiz (i=1), each weekly quiz (i=2), each major section examination (i=3), the final examination (i=4).	32
	0	...not planned...	
e(13,i)	1	A review planned for each topic quiz (i=1), each major section examination (i=2), the final examination (i=3).	31a 31d 31e
	0	...not planned...	
e(14,i)	1	Scheduled review planned before each topic quiz (i=1), each major section examination (i=2), the final examination (i=3).	32
	0	...not planned...	

Variable	Value	Meaning	Manual Statement No.
e(15,i)	1	Special review materials prepared for each daily quiz (i=1), each weekly quiz (i=2), each major section examination (i=3), the final examination (i=4).	33
	0	...not prepared...	
e(16,i)	M	Number of minutes required to review for each daily quiz (i=1), each weekly quiz (i=2), each major section examination (i=3), the final examination (i=4).	34
e(17,i)	1	Special review materials prepared for each topic quiz (i=1), each major section examination (i=2), the final examination (i=3).	33
	0	...not prepared...	
e(18,i)	M	Number of minutes required to review for each topic quiz (i=1), each major section examination (i=2), the final examination (i=3).	34
e(19,i)	M	Number of minutes required for each topic quiz (i=1), each major section examination (i=2), the final examination (i=3).	17
e(20,i)	M	Number of minutes required for each daily quiz (i=1), each weekly quiz (i=2), each major section examination (i=3), the final examination (i=4).	17
e(21,i)	1	Special instructor provided for the slow track (i=1), the fast track (i=2).	4a 4b
	0	...not provided...	
e(25,1)	1	When variable pacing is being used, the students are rewarded for achievement.	9a or 9b
	0	...are not rewarded.	
e(26,i)	0	No proctor used for the topic quiz (i=1), the major section examination (i=2), the final examination (i=3).	21
	1	An instructor...	
	2	An instructor's aide, a student instructor, or a clerk...	
	3	A student leader...	
e(27,i)	0	No proctor used for the daily quiz (i=1), the weekly quiz (i=2), the major section examination (i=3), the final examination (i=4).	21
	1	An instructor...	
	2	An instructor's aide, a student instructor, or a clerk...	
	3	A student leader...	

GLOSSARY

Adaptivity; adaptive instruction: Instruction that provides some students in a course with different instruction than others. There are many reasons for adapting instruction and many techniques for doing it. Some reasons are differences in (1) prior student preparation for the course; (2) innate characteristics (intellectual, psychological, or physical) that affect the student's learning ability; and (3) "learning style," particularly the rate at which the student can master material. Learning rate quite probably depends on both student capability and motivation.

Techniques for adaptivity include adjusting *what* is taught or *how* it is taught to student achievement, learning capability, or maturity. See *grouping, tracking,* and *variable pacing.*

Adaptive programs: Instructional programs presented by a communication medium that adjusts the content of the presentation to the student's response, and may be either response-paced or learner-paced. The adaptivity of content may consist of a discussion of why a particular response is right or wrong, branch the student to materials of varying levels of difficulty, present him with remedial instruction, or leapfrog him past material he has mastered. See *learner-paced* and *response-paced.*

Affective domain: Subject matter pertaining to feelings, emotions, and attitudes.

Appropriate communication medium: Any communication medium that can carry the message. There are eight classes of communication media, including such specific examples as film, TV, audio tape, radio, and books. Each class is appropriate to a different type of message.

Average student: The student for whom the bulk of the instruction is designed. Average refers to the student population of immediate concern to the designer. The average student in a given course may have more or less capability to learn the subject than the norm for those of his own age or experience.

Basic instruction: See *learning event, type of instruction.*

Between-session adaptivity: Instruction adapted between periodic sessions of instruction. The adapter reviews the record of the learner's response to one session to obtain guidance for preparing the subsequent session.

Capability (student): Student ability to learn the material. Capability is a mixture of motivation, prior achievement, and innate traits (mental, emotional, or physical).

Carrel: A table with shelves for books, tapes, and the like that is often partitioned or enclosed and is used for individual study.

Cognitive domain: Subject matter pertaining to the recall or recognition of knowledge and the development of intellectual capabilities and skills.

Communication aids: Audiovisual aids such as flip charts, mockups, and Vu-graphs requiring the message sender to be present at the point of reception.

Communication medium: A self-contained means of communicating—the message sender need not be present at the point of reception.

Complex instruction: Instruction that requires student mastery of several interrelated steps, facts, or the like to attain the instructional objective, such as solving a problem, writing an essay, or checking a piece of equipment.

A lesson on the causes of the Civil War, for instance, can be relatively complex if the student is expected to comprehend the political, social, and economic situations that existed in the North and South and to understand how these situations reinforced the South's move to secession. If the lesson only requires the student to memorize a list of causes of the Civil War, however, relatively simple instruction would be involved.

Relatively complex skills typically cannot be mastered by simple, automatic drill exercises and often can be taught most effectively by giving step-by-step directions or follow-me demonstrations.

Concurrent adaptivity: An adaptation of instruction that occurs during instruction, with the agent of instruction and the learner interacting directly.

Constructed response: Devised by the student, who responds by producing something—speaking, writing, drawing, gesturing, using a tool, operating a machine, making something. Compare *selected response.*

Conventional instruction: Includes classroom methods such as lecture, oral quiz, guided discussion, and drill, plus the use of texts and workbooks. Also includes instructor demonstrations in the laboratory.

Covert response: A response that is not observable—an internal reaction.

Discussion: Two types are considered here. (1) A relatively impromptu session set aside after a segment of basic instruction to answer student questions or to

stimulate student discussion of material just covered. Not considered a separate learning event in the Curriculum Analysis but taken into account in the DISTAF program for determining instructional strategy. See *question-and-answer.* (2) A learning event prepared primarily to teach students to converse and interact in a group; considered as Type II instruction (team skills).

Drill: An activity intended to help the student learn a relatively simple skill by repeated, relatively automatic response to a stimulus, which is usually provided externally as in typing from printed or written text or repeating the pronunciation of foreign words. The student provides his own stimulus in most independent study. See *practice.*

Equipment: See *special equipment.*

Evaluation: Any measurement or assessment of student achievement, formal or informal. A quiz, test, performance test, or final examination, used to measure student progress and, in some instances, to regulate advancement from unit to unit or section to section.

Event, learning: See *learning event.*

Examination: A formal evaluation.

Facilities: See *special facilities.*

Fixed-duration programs: Media presentations that occupy a fixed (invariant) period of time; films, television programs, and audio tapes are examples. Anything that "runs" essentially without interruption and whose pace or content cannot be changed from the outside. A user cannot ordinarily go back over the material or select material at random from within the program as he can, for example, with books and workbooks. See *internal random access.*

Follow-me instruction: A step-by-step demonstration of procedures which students copy or which students practice following step-by-step directions. Such instruction applies only to individual skills and is used in either Type II or Type III instruction.

Formal evaluation: See *examination.*

Groups: Homogeneous divisions of a heterogeneous class by student capability or preparation for a course and thus the special curriculum they follow. Permits regrouping from time to time to adjust to the complexity of the material.

Independent study: Study by individual students or groups of students at a time of their own choosing at home or at school, with no instructor or monitor present. Includes homework. Synonym for unscheduled instruction.

Integrated stimuli: Stimuli for overt student responses that are integrated with the presentation of material; the presentation allows time for the student to respond or halts entirely until he gives the correct response.

Internal random access (IRA): Required when the individual needs to *study* a presentation, as distinguished from merely attending to it, with or without response. Full IRA provides the following controls: start, stop, freeze-frame in the case of motion-visual media, fast forward, fast reverse, and some kind of indexing system. Partial random access may lack freeze-frame and/or indexing. Conventional textbooks have internal random access; scrambled books and filmstrips usually do not.

Interrelated objectives: See *simple instruction* and *complex instruction.*

Learner-paced programs: Instructional programs that can be presented by any medium if they are used in such a mode that the program contains integrated response stimuli, and either stops automatically or the learner himself may stop it manually after each stimulus to give his response. When the learner completes his response, he restarts the program. For example, the program may demonstrate a step to take and then show what the results should be. The student then copies the step and compares his results with those shown. If he is satisfied with the match, he signals the program to proceed to the next step. Since the learner is evaluating his responses (rather than a machine doing it), constructed responses may be used.

Programmed texts, like any printed materials, are paced by the user's reading rate. Since they integrate stimuli for response, they are further paced by the user's responses. Since the user of a programmed text evaluates his own responses, whether constructed or selected, programs in this medium are learner-paced. The variation known as the scrambled book attempts some degree of adaptivity, directing the user to different material according to his responses. Although printed, programmed materials are not designed for free access, some learners do skip around in them, sampling the various branches supplied, and to some extent choosing their own content. Thus, these may be considered either learner-adapted or program-adapted.

Learning event: Any instructional activity that can be assigned to a single subcategory of instruction.

Lesson: A unit in a course based either on content or time interval. May be less than, equal to, or greater than a topic. See *topic.*

Lock-step instruction: Such teaching exposes all students to approximately the same basic instruction at the same time; all students are also given the same examinations at the same time. There may, however, be provisions for remedial sessions or enrichment lessons in conventional lock-step instruction. In addition, tracking or within-class grouping may be used.

Major section: See *section.*

Materials: Media software. Either instructional aids or communication media programs (including printed materials).

Media: See *communication medium.*

Model of Performance: Demonstration of a skill that the learner must master.

Modularized materials: Materials that deal with small units of subject matter prepared for several levels of learning difficulty. The definition is more "operational" than conceptual. If the materials are sufficiently flexible that programs may be drawn from them to fit each student's prior background and capability, they are modularized.

Objective tests: Examinations whose items call for *selected responses.*

Overt response: An observable response.

Pacer: The agent that adjusts the rate of stimuli presentation to fit the student's learning rate: the learner himself, the instructor, a response-paced program, or a student leader.

Performance: Instruction in which the student is learning how to *do* something (not simply acquiring ideas or information, but acquiring a skill). Performance denotes student activity in *Type II* or *Type III instruction.* For example, making a map is Type II performance; repairing an engine, Type III. Student responses in Type I instruction (answering questions, filling in blanks in a workbook, etc.) are not considered performance.

Practice: Student performance in learning relatively complex skills as distinguished from performance in learning relatively simple skills that we term *drill.* Practice is less repetitive and automatic than drill; a student may practice some complex skill, such as troubleshooting or writing a business letter, only a few times during the course and may have a slightly different assignment each time. The presentation of stimuli is less important for practice than for drill, but the demonstration of skills to be learned is more important.

Presentation: Any communication to the student. Includes transmitting facts or concepts; demonstrations; giving directions; supplying stimuli for drill; describing problems to be solved.

Psychomotor skills: Skills requiring muscular movements, usually manipulative, e.g., hand-eye coordination, pronunciation, handwriting, and using tools. Because most such skills require a cognitive support (are more than automatic motor responses), we arbitrarily use the term psychomotor to refer to all motor skills.

Question-and-answer: A period for the informal answering of students' questions or for discussion. Does not include questions answered during the course of instruction. Not considered a separate learning event in the Curriculum Analysis; MODIA automatically accounts for them on the basis of stated strategy. See *discussion.*

Remedial instruction: Instruction intended to assist students who fail to master a particular lesson or learning event, as opposed to actual review or makeup sessions.

Response-paced programs: Instructional programs that can be presented by any medium if they are used in such a mode that the program contains integrated response stimuli, and stops after each unit of presentation (or frame) to allow the learner to select a response, then proceeds to the next unit of presentation only when the correct response has been selected. Most simple teaching machines (without branching) present response-paced programs. Since student responses must be sensed and evaluated by machine, constructed responses cannot be used; machine scoring and recording are possible, however.

Review: An abbreviated version of earlier instruction to refresh the learner's memory or skill in preparing for an examination. Not listed as separate learning events in the Curriculum Analysis; MODIA automatically accounts for them on the basis of stated strategy.

Scheduled instruction: Instruction designated for a specific time and place.

Scoring deskwork: Scheduled instructional time set aside for evaluation of a student's work by the student himself or by another student. Such sessions are not considered learning events in the Curriculum Analysis; MODIA automatically accounts for them on the basis of stated strategy.

Section: An unbroken sequence of *topics* treated as a unit either because it deals with related course content or because it occupies a major fraction of the course length. The definition is intended to identify course subdivisions that are subject to examination.

Selected response: Student responses selected from among two or more answers, or placing a list of items in some correct order. Mutiple-choice, true-false, matching, and ordering all call for selected responses. Compare *constructed response.*

Simple instruction: Instruction that does not require the student to master several interrelated steps, facts, or the like. Activities that characterize simple instruction include memorizing foreign words, learning multiplication tables, plotting points on a graph, target practice, or sending code. Action verbs that typify relatively simple instruction in the cognitive domain include: name, list, spell, identify, choose, find, select, and match. Relatively simple skills are those that the student can typically master by fairly routine, repetitious, or automatic drill.

Note that these may not be simple skills for *some* students whose background is deficient. Therefore, determining whether the instruction is simple or complex depends on the level of average student capability as much as it does on the skill itself.

Special equipment: Equipment (or other materials) students must work with other than the traditional paper and pencil, drawing instruments, slide rules, or other small implements. Such materials (1) are so expensive and fragile (such as precision measuring instruments) or dangerous (such as corrosive acids) that a monitor or other responsible person must supervise student work or (2) require special facilities.

Projectors, playback devices, and the like, that are used for communicating with the student are not covered by this term unless they themselves are the subject of study.

Special facilities: Areas that differ from a conventional classroom, such as workshops, laboratories, hangars, playing fields, and gymnasiums.

Stratified materials: Materials that present the same general subject on several levels of difficulty. Stratified materials can be completely modularized for individualized instruction or can be prepared in graded sets for use by groups or tracks within a class or at a given grade level.

Subcategory of instruction: An instructional activity with a particular combination of resource requirements.

Team: Two or more individuals who work together. In our sense, the people playing a two-handed game form a team as do the people using a transit and chain to determine the placement of a survey marker.

Topic: A coherent set of ideas or skills that the student masters as a unit of course content and that could serve as the subject of formal evaluation. Could span several class sessions or could occupy less than a single class session. The definition provides a finer division of course content than the major section for scheduling examinations and reviews. See *lesson* and *section.*

Tracks: Subdivisions of a class *group* homogeneous with regard to student capability and the special curricula they follow. Students generally remain in the same track throughout a course.

Types of instruction: A broad categorization of instructional activity intended to aid system design.

Type I instruction: Requires no student use of special equipment and no student performance in special facilities. In addition, students are not acquiring skills (cognitive, psychomotor, motor, or social) through drill or practice. Type I activities typically occur in the classroom and concern the presentation of facts or

concepts for the student to master or the presentation of goals or objectives to motivate him with a sense of direction for his learning. Frequently includes affective objectives (such as changes in attitude toward the subject) and demonstrations. Such instruction involves presentations, and may or may not contain integrated stimuli that require overt student responses.

Type II instruction: Like Type I instruction, requiring no special facilities or equipment for student performance; however, students master *skills* that require drill, practice, or performance. The student learns to make particular responses when provided with directions and stimuli. Activities are those in which the student must do something besides answer questions. Also includes the presentation of models of skills to be mastered (even though no student performance may be required during the demonstration) because demonstrations are frequently given immediately preceding or concurrent with student performance. Therefore, it may often be convenient to use the same means to present the models as those used to present directions for performance or actual drill stimuli. If a performance model is to be given but *not* immediately preceding or concurrent with the drill, practice, or performance session, it may be categorized as a demonstration under Type I instruction. Type II instruction can include pure skill demonstrations (with no student response); follow-me demonstrations in which the students perform each step as they are directed or as it is presented; presentation of directions and stimuli for performance; and pure performance (with no presentation to the student).

Type III instruction: Any instructional activity that requires the students to work with special equipment (such as a simulator, a piece of machinery, or a musical instrument) or in a special facility (such as a shop, a laboratory, a parade ground, or other special area) or both. See *special equipment* and *special facilities.*

The instructor is *not* using Type III instruction when he uses special equipment (such as a projector or mockup) to demonstrate a procedure or to clarify a concept (such as operating aircraft flight controls), unless the students are also *required* to use the same equipment at the same time (or immediately afterward). The rules for classifying performance models and presentations for Type II instruction are the same as those for Type III instruction, namely, if the model immediately precedes or is concurrent with student performance, it is most conveniently treated as Type III instruction; if the model will be separated in time from student performance, it may be treated as Type I instruction.

Unscheduled instruction: See *independent study.*

Variable pacing: The rate of stimuli presentation to the student or student group varied on the basis of student response. Pacing may be varied to fit each individual student's learning rate or to fit the learning rate of a group. The use of response cards or other group response devices can facilitate group pacing, although often hand or voice responses to the instructor's questions can be used for the same effect.

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